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ABSTRACT

This document contains the responses of the Committee of Ontario Deans of Engineering, the Ontario Council on Graduate Studies, and the Association of Professional Engineers of the Province of Ontario to "Ring of Iron: A Study of Engineering Education in Ontario." The study, prepared by the Council of Ontario Universities, was to cover both the undergraduate and graduate fields, and examine student flows, curricula, research, staff, facilities and costs with a perspective developed from an analysis of the career patterns of engineering graduates. The objective was to create a master plan that might be used as a guide for rational growth of engineering education in Ontario during the 1970s. The plan that was devised endeavors to provide for the highest attainable quality, the best use of resources, an opportunity for innovation, and maximum freedom of choice for students. (HS)

Council of Ontario Universities
Conseil des Universités de l'Ontario

ED 063526

Statement by the Council of Ontario Universities
and
Responses by
Committee of Ontario Deans of Engineering
Ontario Council on Graduate Studies
Association of Professional Engineers of the Province of Ontario
to

Ring of Iron: A Study of Engineering Education in Ontario

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October 1971

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ED 068073

Statement by the Council of Ontario Universities
and
Responses by
Committee of Ontario Deans of Engineering
Ontario Council on Graduate Studies
Association of Professional Engineers of the Province of Ontario
to

Ring of Iron: A Study of Engineering Education in Ontario

October 1971

Council of Ontario Universities
Conseil des Universités de l'Ontario
102 Bloor Street West
Toronto 181, Ontario

71-13

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INTRODUCTION

Following its meeting on October 5, 1971, the Council of Ontario Universities (COU) issued a statement on the recommendations contained in Ring of Iron: A Study of Engineering Education in Ontario. Release of this statement marked the culmination of a process which began over three years ago, when the then Committee of Presidents of Universities of Ontario decided that a comprehensive review of engineering education in the province should be undertaken. The Committee of Ontario Deans of Engineering was requested to draw up plans for such a study. The CODE proposal was for a study to cover both the undergraduate and graduate fields, and examine student flows, curricula, research, staff, facilities and costs with a perspective developed from an analysis of the career patterns of engineering graduates. The objective was to create a master plan which might be used as a guide for rational growth of engineering education during the 1970s. Such a plan should endeavour to provide for the highest attainable quality, the best use of resources, an opportunity for innovation, and maximum freedom of choice for students.

The strategy chosen for this investigation was that of a "commission", whereby an independent study group would be appointed, and requested to produce a report which would be published as received. Work commenced in October of 1969, with the appointment of a full-time director under the guidance of a liaison committee representing CPUO and CODE. Dr. Philip A. Lapp, an engineer from industry, was appointed study director. The addition of two other members formed the study group. The two, appointed on a part-time basis, were Dr. J.W. Hodgins, former Dean of Engineering at McMaster University, and Dr. C.B. MacKay, former president of the University of New Brunswick.

In consultation with the engineering schools, a questionnaire was developed, calling for the generation of data from each university. In addition, a brief was received from the Association of Professional Engineers of Ontario (APEO). These submissions formed the basis upon which many of the recommendations were developed. The study group travelled extensively--132 organizations were visited in Canada, the United States and Europe, and informal hearings were held at each Ontario university, when members of the study group spoke with students, faculty and staff. More than 300 students were involved in these discussions, and a separate student questionnaire provided a variety of viewpoints from several hundred more.

The report, Ring of Iron, was received by the Committee of Presidents at its meeting in January 1971. A process of review of the report's recommendations was established, whereby the Committee of Ontario Deans of Engineering requested engineering faculties to submit briefs in response to Ring of Iron which, together with briefs from discipline groups, would be used as a basis for preparing a brief from CODE to CPUO. The necessity for study of the report by each university concerned, as well as by the faculties of engineering, was recognized by requesting the dean of engineering at each institution to serve in a liaison capacity to convey the views of his university as well as those of the engineering faculty itself to CODE. Other briefs were prepared by the Ontario Council on Graduate Studies, commenting on the Ring of Iron recommendations in the area of graduate studies, and from the Association of

Professional Engineers of the Province of Ontario. The responses from CODE, OCGS, and APEO were received by the Council of Ontario Universities in September 1971.

The following statement by COU takes the form of a recommendation to the universities and to the Committee on University Affairs that the statement in its entirety be used as a basis for action on Ring of Iron.

October 12, 1971.

COUNCIL OF ONTARIO UNIVERSITIES
CONSEIL DES UNIVERSITÉS DE L'ONTARIO

102 BLOOR STREET WEST
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October 6, 1971.

Statement by the Council of Ontario Universities on Ring of Iron

At its meeting on October 5, 1971, the Council of Ontario Universities (COU) adopted the following statement as its position on the report Ring of Iron: A Study of Engineering Education in Ontario. COU recommends to the universities and to the Committee on University Affairs that this statement in its entirety be used as a basis for action on that report.

The report, Ring of Iron, prepared by Philip Lapp and colleagues on engineering education in Ontario, was completed in December 1970. Since that time it has been subjected to careful scrutiny by COU, by the universities, the Committee of Ontario Deans of Engineering (CODE), the Ontario Council on Graduate Studies (OCGS), and the Association of Professional Engineers of the Province of Ontario (APEO). The latter three bodies have provided COU with analyses of the Lapp Report and have indicated their position in respect of its recommendations. COU has studied these reports and now makes its own recommendations.

A number of the Lapp recommendations have been explicitly or implicitly accepted without amendment by the provincial bodies which have commented on the report. The recommendations in this category include the following, all of which are now endorsed by COU:

3.2* each engineering school undertake a study of its teaching laboratories, and establish ways in which the students will use them to obtain design experience.

4.1 a talk-back television network in Ottawa be thoroughly explored.

5.1 the criteria of acceptability of graduate degrees in engineering should be recast in order that a thesis based on design or systems synthesis may be suitably assessed. This could involve the establishment of a new degree at the doctorate level.

7.3 CODE undertake the appraisal of proposed new undergraduate programs, using essentially the same procedures employed by OCGS in regard to new graduate programs. Also, CODE should evaluate the need for each new program with respect to academic, cost and manpower considerations. In regard to such appraisal, CAB** should participate so as to avoid unnecessary duplication and permit simultaneous accreditation.

* Numbers refer to Ring of Iron.
** Canadian Accreditation Board

7.4 CAB re-accreditation, requested and/or approved by APEO, be coordinated through CODE, which ultimately should be in a position to provide the required quantitative data.

10.1 it is essential that changes in the formula be considered concomitantly with the development of the system.

11.2 a three-way cooperative program between the university /Queen's/, Cambrian College in Sudbury, and the mining industry in that area be thoroughly explored.

11.4 Waterloo continue to be the only engineering school offering a cooperative program in Ontario throughout the 1970's, and that its engineering be limited to this type of program.

11.15 no further engineering schools be established prior to 1980.*

12.2 each school develop a technique for tracing the career histories of its graduates, and maintain records for its own use and for use in manpower studies.

In addition to the above group of recommendations accepted by COU without alterations, many recommendations have been accepted with reservations or amendments as set out below. One group of recommendations make proposals concerning the content of undergraduate and graduate programmes for various institutions, and levels of enrolment for those programmes. Following are amended statements concerning the content of programmes at certain universities; enrolment levels are dealt with in a separate section of this statement.

11.1 Amend to read: The University of Toronto continue to offer a full spectrum of undergraduate engineering programs.

11.3 Amend to read: Queen's University continue to offer a full spectrum of undergraduate engineering programs.

11.5 Amend to read: Waterloo continue to offer a full spectrum of undergraduate engineering programs.

11.7 Amend to read: McMaster continue to offer a full spectrum of undergraduate engineering programs.

11.8 Amend to read: Carleton retain its present undergraduate program structure, and Carleton explore jointly with Ottawa ways to collaborate with local governmental and industrial laboratories, for example, by means of a talk-back television network.

11.10 Amend to read: COU takes note with approval of the discussions and studies relating to environmental engineering taking place at Western.

* COU did not consider it necessary to comment on recommendations 11.16, 11.17 and 11.18 since their intent is covered under 11.15.

11.11 Amend to read: COU accepts Windsor's intent to emphasize "liberal engineering" and "design", in its undergraduate programmes. Special roles in the graduate area will be determined by the methods and procedures outlined below.

11.12 Amend to read: COU concurs with the special role for Guelph in the undergraduate areas as defined in recommendation 11.12 of Ring of Iron.

11.14 Amend to read: Beginning in 1972 or as soon thereafter as possible, Lakehead should establish a two-year full-time engineering degree programme specially designed to accommodate diploma technology graduates. The disciplines offered should be related to the needs of the district. In addition, it should continue to offer existing diploma courses in technology. As soon as the new two-year degree programme has been established, the present engineering programme should be terminated by admitting no new freshmen.

With respect to the Ring of Iron recommendations on undergraduate enrolment, COU makes the following recommendations: We recommend that five-year targets for the total system enrolment be determined and reviewed annually by CODE and COU, and that initially the total enrolment as projected in Ring of Iron be accepted. We recommend that freshmen intake be accepted as the control factor for the enrolment in individual schools, that the maximum freshmen intakes recommended in Ring of Iron be accepted* and that unless agreement exists among all engineering schools in the system such maximum recommended freshmen enrolments not be exceeded.

A controversial aspect of the Lapp report is its specific recommendations on how to achieve enrolment limitations at the doctoral level. The recommendation that graduate enrolment be reduced by 17% from its 1970-71 level and that the number of Ph.D. students enrolled be reduced to 450 per year is fully supported by all groups including COU. However, COU, along with CODE and OCGS recommends that the figure of 450 be the target for 1974-75, rather than for 1973-74 for reasons related to avoiding large fluctuations in enrolment as explained in the OCGS critique.

The Lapp report recommends specific numbers of Ph.D. enrollees for each of the universities including discontinuance of the Ph.D. enrolment in certain universities. COU feels that the reasons for the numbers chosen or for the elimination of certain doctorate programmes are not fully documented in the Lapp report. COU also agrees with CODE and OCGS that attention must be given to the numbers of doctorate enrollees by discipline as well as by university. For these reasons COU recommends that for the year 1972-73 doctorate enrolment be reduced in each university below the projected figure for 1971-72 by a pro rata percentage in order to provide 612 doctoral candidates, (the number required to achieve the target of 450 in 1974-75.)** Preliminary acceptance of the OCGS method for reducing Ph.D. enrolment (by limiting new Ph.D. enrolments to achieve a total system number of 450 by 1974-75) is based on plans for discipline planning assessments respecting Ph.D. programmes to be

* It is understood, as part of this recommendation, that the maximum for Toronto be accepted as 10% above the Ring of Iron figure, and that for Waterloo 3% above. This is in line with current enrolments in these schools, and since certain schools are not expected to grow to their recommended maximum, this should not lead to exceeding the total system enrolment. The special case for Laurentian is dealt with subsequently in this statement.

** See table

initiated immediately and completed as rapidly as possible. Such assessments will be carried out by ACAP in cooperation with CODE; they are to incorporate capability, demand and quality correlates, and are to be used to provide specific recommendations on changes for the total Ph.D. enrolment, and for the division of the enrolment amongst universities and amongst disciplines. The assessments are to incorporate a review of the effects of the pro rata reductions in 1972-73, and to recommend a mechanism for continuing review of Ph.D. enrolments.

With respect to total graduate enrolment, the following amendment of recommendation 9.1 has been accepted by COU:

9.1 Amend to read: Over the next two years the estimated graduate enrolment of 2,000 full time equivalent students for 1970-71 be reduced by 17%, after which graduate enrolment should be limited to a number equal to the previous year's bachelor graduations. These enrolment figures apply to the engineering departments as identified in Ring of Iron.

Other recommendations accepted by COU with amendments are as follows:

2.1 Amend to read: Beyond senior mathematics, the secondary school Honours Graduation Diploma should be the basic requirement, set at a level of performance decided upon by the faculties of engineering, with assured aptitude for and knowledge of the physical sciences.

3.1 Amend to read: Innovative opportunity, such as in the form of design should be brought into all years of engineering programs, despite the elementary character of the design examples. The gain in motivation and morale would amply repay the expenditure of time.

3.3 Amend to read: Universities establish a replacement policy with respect to engineering laboratory equipment.

3.4 Amend to read: Each faculty should have a standing committee on curriculum with substantial student representation, of which the responsibility is to ensure that there is an articulated sequence of courses in each stream. Such a committee should regard as its prime function the continuous monitoring and updating of the curricular system.

6.1 Amend to read: Both universities and industries should recognize joint appointments as part of the career structure of their senior staff; these appointments should be increased as far as possible. We would hope that in time there would be at least one joint appointment in each department, certainly in those relevant to industry. By this we understand a system of part-time appointments.

7.1 Amend to read: that within the university system part-time undergraduate studies be introduced as an acceptable alternative path to a recognized bachelor's degree in engineering, and that when this scheme is fully operative, the present APEO examination system be terminated.

7.2 Amend to read: COU notes that CODE is prepared to enter into discussions with the APEO on whether and how the universities might contribute to re-qualification of professional engineers.

7.5 Amend to read: COU notes that CODE has endorsed the recommendation that all engineers engaged in teaching in Ontario be registered members of the profession.

9.2 Amend to read: COU supports the intention of the Canadian Council of Professional Engineers to establish a permanent Canadian Engineering Manpower Commission in order to provide national and regional data on engineering manpower in Canada.

A small residue of recommendations in the Lapp report remain with which COU does not agree. They are:

4.2 a report be prepared for Ontario similar to that prepared by Alan M. Cartter, dealing with graduate education in the United States.

COU concurs with the view of ACAP that the aims towards which this recommendation is directed will be much more satisfactorily met by the succession of planning assessments now proceeding.

11.6 the Faculty of Engineering at Waterloo undertake negotiations to enable it to be reorganized into a technical university, with a separate Board of Governors and Senate, but in affiliation with the University of Waterloo.

This recommendation appears to COU to relate entirely to matters of organization within a single university and COU does not feel it would be proper to offer advice. The University of Waterloo is aware of the recommendation and will be competent to respond as it sees fit.

11.9 Ottawa create a common-core undergraduate curriculum in a pattern similar to that at Carleton; graduate enrolments be reduced to 90 students by 1973-74, including 60 doctoral candidates to be shared equally with Carleton, and graduate student and faculty research be directed towards the field of information systems engineering in a joint program with Carleton.

COU agrees with the comments made by CODE, namely, "CODE recognizes Ottawa's bilingual/bicultural nature and supports the continuance of graduate and undergraduate programs in the traditional engineering disciplines."

11.13 the existing engineering program at Laurentian University be terminated, and no freshmen be admitted for 1971-72.

Both the arguments in support of this recommendation and those for continuing the program have substance. COU is impressed with the comments of CODE that "in spite of the arguments for termination of Engineering at Laurentian... there are social and geopolitical factors which must be considered. Sudbury is a community of some 160,000 of unique importance to life and development of Northern Ontario." In the last analysis the question is a matter of public policy and COU suggests that Laurentian University consult with the government of Ontario before making a decision.

11.19 the Royal Military College develop a liberal engineering program, based on the successful model now in operation at Dartmouth and Harvey Mudd.

COU agrees with CODE that "since RMC is a part of the national system of military colleges and not a provincial institution, we consider it to be outside the provincial system of engineering schools."

12.3 each engineering school undertake its own annual unit cost study, in order that trends may be detected and policies established for the continuous assessment and control of costs.

Cost studies are best undertaken on a university-wide or system-wide basis.

12.1 and 12.4 CODE coordinate the collection of information, as a pilot project, for a data bank to be established by CPUO.

CODE assess the information to be collected for the CPUO data bank, and recommend to CPUO what additional data should be assembled to facilitate program assessments and accreditations.

COU has established procedures for determining the nature and extent of data collection.

In addition to the above recommendations COU makes the following further recommendations beyond those included in the Lapp report:

That Ryerson be invited to discuss with CODE its proposals for the B.Tech. programmes in traditional engineering technology areas.

COU endorses the suggestion on page 11 of Ring of Iron that engineering schools should promote student exchanges between Ontario and Quebec (such as that between Western and Laval) in the interest of fostering Canadian unity. It also recommends that more recognition be given to the special problems of bilingual institutions.

Table 1

Models of Engineering Ph.D. Enrolment

The appropriate numbers for scaling down as smoothly as possible to 450 in 1974-75 depend on the 1971-72 enrolment (not yet reported) and on the numbers graduating and withdrawing each year. This is illustrated by four examples which span the likely numbers.

	I	II	III	IV
1970-71 Total Enrolment	671	671	671	671
1971 Graduations and Withdrawals	165	165	160	160
1971-72 New Entrants	192	214	194	209
1971-72 Total Enrolment	698	720	705	720
1972 Graduations and Withdrawals	195	195	168	168
1972-73 New Entrants	109	110	100	93
1972-73 Total Enrolment	612	635	637	645
1973 Graduations and Withdrawals	185	185	196	196
1973-74 New Entrants	117	111	102	95
1973-74 Total Enrolment	544	561	543	544
1974 Graduations and Withdrawals	220	227	197	202
1974-75 New Entrants	126	116	104	98
1974-75 Total Enrolment	450	450	450	450

COMMITTEE OF ONTARIO DEANS OF ENGINEERING

CODE RESPONSE TO "RING OF IRON"

A REPORT

TO

THE COUNCIL OF ONTARIO UNIVERSITIES

September 17, 1971

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RECOMMENDATIONS

(1) We accept the concept of a system of Engineering Education in Ontario characterized by distinctions in roles for the constituent institutions and developed in scope and size to meet the needs of the Province and of Canada.

(2) Specifically, we accept the necessity for overall enrolment planning for the system.

(3) We appreciate the necessity of seeing Engineering Education in the light of social needs and the importance of developing programs to satisfy these needs.

(4) Since CODE endorses the concept of special roles for the schools in the system, it will undertake in collaboration with OCGS, ACAP, and various professional bodies, to set up the mechanism to evaluate graduate and undergraduate programs in all schools on the basis of need, objectives, academic capability and performance analysis.

(5) CODE supports the continuation of Carleton's undergraduate program structure as recommended by "Ring of Iron" and endorsed by Carleton. CODE recommends that special roles in the graduate area be determined by the methods and procedures outlined in this report with continued emphasis on collaboration with Ottawa.

(6) CODE concurs with the special role for Guelph in the undergraduate areas as defined in recommendation (11:12) of "Ring of Iron".

(7) It is recommended that, beginning in the 1972-73 academic year, Lakehead University establish the final two years of a full-time engineering degree-granting special conversion program specifically designed to accommodate carefully selected diploma technology graduates, which will give these students the opportunity to complete the degree in a minimum of two years. Existing diploma programs in engineering technology shall continue to be offered and the options are to be related to the requirements for regional development of Northwestern Ontario. As a consequence of implementing the preceding, the existing program comprising the first two years of engineering would be phased out by May 1973.

(8) We recommend that the two year program at Laurentian be continued provided that there be no extension to a degree program until there is a clearly demonstrated need, which CODE would assist in determining; and that there be a continuing effort to develop an emphasis on engineering in the North as a theme for the program.

(9) CODE recognizes Ottawa's bilingual/bicultural nature and supports the continuance of Ottawa's undergraduate programs in the traditional

engineering disciplines. At the graduate level CODE encourages entended collaboration with Carleton and recognizes the need for and endorses support of bilingual graduate programs in engineering, but not restricted to information systems.

(10) CODE endorses the policy and procedure proposed by Waterloo for responding to the proposal that there be formed an independent technical University. In due course CODE expects to receive the findings of the Waterloo study group, and to make its own recommendations.

(11) CODE takes note with approval of the discussions and studies relating to environmental engineering taking place at Western.

(12) CODE accepts Windsor's intent to emphasize 'liberal engineering' and 'design', in its undergraduate programs. Special roles in the graduate area will be determined by the methods and procedures outlined in this report.

(13) All schools in this system including McMaster, Queen's, Toronto and Waterloo for which "Ring of Iron" recommends a full spectrum of programs will be included within the plan for the identification and establishment of special roles. Existing as well as new programs will be subject to evaluation.

(14) We concur with "Ring of Iron" recommendation (11:16) that York University not develop any programs in Engineering and with recommendation (11:15) that no further engineering schools be established prior to 1980.

(15) Since RMC is a part of the national system of military colleges and not a Provincial institution, we consider it to be outside the Provincial system of engineering schools.

(16) CODE recommends that COU, in consultation with DUA if deemed advisable, designate an appropriate consultative mechanism to ensure an immediate review and planning assessment of the Engineering Technology degree programs in relationship to the existing university engineering programs.

(17) CODE fully supports the proposal for the establishment of a National Engineering Manpower Council. We expect to be asked by it to assist with the input of data from the Ontario Engineering Faculties, and to advise on the operations of the Council. In this matter CODE looks to COU for administrative assistance.

(18) We recommend that, in conjunction with the monitoring system recommended below, five year targets for the total system enrolment be determined and reviewed annually, and that initially the total enrolment as projected in "Ring of Iron" be accepted.

(19) We recommend that freshman intake be accepted as the control factor for the enrolment in individual schools, that the maximum freshman intakes recommended in "Ring of Iron" be accepted, and that unless agreement exists among all engineering schools in the system, such maximum recommended freshman enrolments not be exceeded.

(20) CODE recommends that, with the assistance and facilities of COU, it immediately be authorized to initiate a continuing quantitative appraisal of the dimensions of the engineering education system.

(21) We recommend that there should be no limitation of numbers imposed on part-time graduate students.

(22) We agree with the statement in "Ring of Iron" (p. 15) that the number of full-time Masters students should increase naturally to a maximum of 1850 by 1980.

(23) CODE records its concern for the number of graduate students in the system relative to the demand, the cost of graduate study, especially at the Doctorate level, and implied criticism concerning the large number of non-Canadian students.

(24) We do not accept the recommendation that PhD programs be eliminated at Guelph, Western, and Windsor. The future of these, as of all PhD programs in the system, should be determined on the basis of academic quality and demand.

(25) CODE supports the reduction of the total full-time PhD enrolment in the system and accepts the level of 450 as being reasonable for the year 1974-75, having regard for the current utilization of PhD graduates.

(26) the results of the cost analysis undertaken as part of the study are unfortunately misleading, and we recommend that all possible action be taken to mitigate the consequences.

(27) cost information provided in the "Ring of Iron" should be viewed as approximate so that gross differences only can be regarded as of any significance. In future, such cost studies as are deemed appropriate should be conducted on a university and system-wide basis following an agreed upon format.

(28) CODE affirms that the apportionment of resources between the graduate and undergraduate areas is essentially a policy consideration at each school and that the only general matter of importance is the total budget.

(29) We propose that regular consultation be established between CODE and the Ontario Department of Education.

(30) We accept an amended version of recommendation (2:1) of "Ring of Iron", concerning admissions, to read:

"Beyond senior mathematics, the secondary school Honours Graduation Diploma should be the basic requirement, set at a level of performance decided upon by the faculties of engineering, with assured aptitude for and knowledge of the physical sciences."

(31) CODE endorses with reservations recommendation (7:1) of "Ring of Iron", that part-time undergraduate studies be an alternative path to a bachelor's degree and ultimately replace the persent APEO examinations.

(32) CODE endorses recommendation (7:5) of "Ring of Iron" that those engineers engaged in teaching in Ontario should be registered members of the profession.

(33) CODE is prepared to enter into discussions with the APEO on whether and how the universities might contribute to requalification of professional engineers.

(34) CODE is prepared to facilitate accreditation of undergraduate programs by the Canadian Accreditation Board through provision of the required quantitative data.

(35) CODE is in general agreement with recommendation (6:1) of "Ring of Iron" concerning cross-appointment of staff between university, industry and government.

(36) CODE recommends that (3:1) of "Ring of Iron" be modified and extended to read "Innovative opportunity, such as in the form of design should be brought into all years of engineering programs, despite the elementary character of the design examples. The gain in motivation and morale would amply repay the expenditure of time."

(37) CODE shares the view recorded on p. 9 of "Ring of Iron" concerning bridges between engineering and the social sciences and humanities.

(38) CODE endorses the suggestion on p. 11 of "Ring of Iron" that engineering schools should promote student exchanges between Ontario and Quebec (such as that between Western and Laval) in the interest of fostering Canadian unity. It also recommends that more recognition be given to the special problems of bilingual institutions.

(39) CODE endorses recommendations (3:2) and (3:4) of "Ring of Iron" concerning teaching laboratories and student participation on curriculum committees.

(40) CODE endorses recommendation (3:3) calling for the establishment of a depreciation policy with respect to engineering laboratory equipment.

(41) In view of the financial implications of a reduction in PhD enrolment, of some disengagement of research from graduate studies, and of the institution of a depreciation policy with respect to laboratory equipment, CODE supports a recasting of the present BIU formula. This is in agreement with recommendation (10:1) of "Ring of Iron".

INTRODUCTION

Following the release of "Ring of Iron" on January 15, 1971, CODE issued a preliminary statement on March 8 (reproduced here in Section II) in which the general thrust of the Report was endorsed, and undertook to provide at the request of the Council of Ontario Universities a more detailed study and report on the specific recommendations of the Report.

CODE requested, each of the nine engineering faculties* in the provincial system plus Laurentian and Lakehead and the discipline groups** to give detailed consideration to the Report and to respond in writing. An analysis of these responses, prepared by Prof. B. Etkin of the University of Toronto, was used as a basis for this formal response to COU. The statements, undertakings and recommendations contained herein are viewed by CODE as the first phase of "a continuing process of implementation" rather than as a final response to "Ring of Iron".

---

* Carleton, Guelph, McMaster, Ottawa, Queen's, Toronto, Waterloo, Western, Windsor.

** Chemical Engineering, Civil Engineering, Electrical Engineering, Engineering Physics/Science, Materials and Metallurgy, Mechanical Engineering.

CODE PRELIMINARY STATEMENT (Issued Mar. 8, 1971)

(1) We accept the concept of a system of Engineering Education in Ontario characterized by distinctions in roles for the constituent institutions and developed in scope and size to meet the needs of the Province and of Canada. As a means of working towards such an objective, we are examining the detailed recommendations of the Report with the view of supporting those which are valid, to forming alternatives for those which are unsatisfactory, and to proposing others which are desirable.

(2) Specifically, we accept the necessity for overall enrolment planning for the system. The analysis of enrolment in the Report aids in establishing a long needed base of information from which to develop an acceptable plan adaptable to changing needs. At the undergraduate level such planning should permit schools to reach or maintain academic and economic viability. A limitation in graduate enrolment is supported, particularly at the PhD level.

While accepting the concept of sensible distinctions in roles for different institutions, we have reservations about the specific recommendations. Further, while the cost study is an important element for the system, the apportionment of cost between undergraduate and graduate areas for some institutions is in question and is now being reviewed.

We regard this as a critical phase in the development of the profession of engineering in Ontario and look forward to the continued involvement of the Association of Professional Engineers and other professional bodies with the system of Engineering Education in the Province.

(3) We appreciate the necessity of seeing Engineering Education in the light of social needs and the importance of developing programs to satisfy these needs.

SPECIAL ROLES

General

(4) Since CODE endorses the concept of special roles for the schools in the system, it will undertake in collaboration with OCGS, ACAP, and various professional bodies, to set up the mechanism to evaluate graduate and undergraduate programs in all schools on the basis of need, objectives, academic capability and performance analysis. A proposal is described in Appendix A.

Special roles at both undergraduate and postgraduate levels (including 'centres of excellence') should normally be based on faculty initiatives. In evolving their own special roles, we expect each School to be sensitive to social and economic needs. Proposals for specific roles originating in outside groups should be considered by CODE and referred as deemed fit to the 'system'. All Schools in the system should be included within the plan for the identification of specific roles, and old as well as new programs should be subject to evaluation.

CODE recognizes the traditional role of OCGS in appraising academic quality, and the mechanisms for evaluation that we propose (Appendix A) include OCGS as an integral part. However, we have our own responsibility and concern for the overall system of Engineering education, of which the graduate programs are but one part. The needs and standards of the Engineering profession have also to be considered in our planning. The existence and content of "Ring of Iron" are evidence of the need to assess the system totally, and not piecemeal.

In evolving special roles several parameters should be considered:

i) The internal environment (academic) of the faculty

ii) the relation of the faculty to the remainder of the institution and to other institutions

iii) the relation of the faculty to the external environment

iv) appraised academic quality

v) appraised performance in serving the external environment (e.g. manpower career profiles)

At the undergraduate level the issue is not one of duplication, which is in fact mandatory at this level. Every undergraduate school has to teach mathematics, physics, chemistry, mechanics, electric circuits, fluid mechanics, thermodynamics, etc. These are the 'sine qua non' of basic training in Engineering. The key issue is that individual schools be stimulated to use their staff initiatives to delineate a spectrum of distinctive identities in undergraduate studies encompassing common concerns for the role of technology in society and for interpreting technology and engineering to others. Some examples of such special roles that already exist are: Guelph - agricultural engineering; Waterloo - cooperative program; Toronto - Engineering Science; Carleton - common core program. "Ring of Iron" has focussed attention on special roles, and it is apparent to us that further distinctive undergraduate programs are emerging in response.

These roles should be appraised as noted above, both institutional reports and CODE-initiated studies being appropriate methods. CODE in collaboration with CAB should establish guidelines for standardization.

At the graduate level, especially the doctorate, duplication is an important issue, because of associated high costs and limited

societal needs. Special roles will be identified and approved by a rational process. Initially, and within a reasonable time, each school will declare what its major graduate specialities are. This will be followed by assessment of the programs. It is only on the basis of successful assessment that centres of excellence and special roles will be recognized and approved. Following the first round of assessment and approval, periodic reappraisal will follow.

Individual Special Roles

The resolutions of CODE pertaining to individual special roles spelled out in "Ring of Iron" are given below. In making these statements, we do not intend in any way to pre-empt the process of definition and assessment of special roles described above. We believe these statements to be appropriate at this point in time, but recognize that alterations in roles may occur in the future as a result of the implementation of our proposals for system planning.

Carleton

(5) CODE supports the continuation of Carleton's undergraduate program structure as recommended by "Ring of Iron" and endorsed by Carleton. CODE recommends that special roles in the graduate area be determined by the methods and procedures outlined in this report with continued emphasis on collaboration with Ottawa.

It is noted that the study of a television teaching network is underway.

Guelph

(6) CODE concurs with the special role for Guelph in the undergraduate areas as defined in recommendation (11:12) of

"Ring of Iron".

It is understood that elective course sequences in the applied humanities and social sciences are an integral requirement of the undergraduate program. CODE also notes that Guelph proposes to concentrate its graduate program in agricultural engineering, biological engineering, and hydrology. These programs will be subject to assessment in the manner previously outlined.

Lakehead

(7) It is recommended that, beginning in the 1972-73 academic year, Lakehead University establish the final two years of a full-time engineering degree-granting special conversion program specifically designed to accommodate carefully selected diploma technology graduates, which will give these students the opportunity to complete the degree in a minimum of two years. Existing diploma programs in engineering technology shall continue to be offered and the options are to be related to the requirements for regional development of Northwestern Ontario. As a consequence of implementing the preceding, the existing program comprising the first two years of engineering would be phased out by May 1973.

In anticipation of the assessment mechanisms later to be developed, CODE has made an ad hoc appraisal of the Lakehead proposal. A CODE subcommittee visited Lakehead on August 24th to study its facilities, resources and programs, and reported to CODE on September 3rd that the potential for the program exists although a satisfactory written proposal for a program, as envisaged in "Ring of Iron" remains to be developed.

Laurentian

(8) We recommend that the two year program at Laurentian be continued provided that there be no extension to a degree program until there is a clearly demonstrated need, which CODE would assist in determining; and that there be a continuing effort to develop an emphasis on engineering in the North as a theme for the program.

In spite of the arguments for termination of Engineering at Laurentian on which the "Ring of Iron" recommendation is based, there are social and geo-political factors which must be considered. Sudbury is a community of some 160,000 of unique importance to the life and development of Northern Ontario. The continuing development of Laurentian University and of its Engineering school is a significant factor in the growth and welfare of this community and hence of Northern Ontario. CODE is prepared to assist Laurentian University in applying its resources (comprising the School of Engineering and other academic units) to the development of an engineering program best suited to its special conditions.

In view of the modest cost of the Laurentian engineering program, and the social and economic advantages it confers on the region CODE considers it a good investment from a cost/benefit standpoint.

Ottawa

(9) CODE recognizes Ottawa's bilingual/bicultural nature and supports the continuance of Ottawa's undergraduate programs in the traditional engineering disciplines. At the graduate level CODE encourages extended collaboration with Carleton and recognizes the need for and endorses support of bilingual graduate programs in engineering, but not restricted to information systems.

Ottawa welcomes the suggestion in "Ring of Iron" that it explore with Carleton the development of a talk-back television network to reach out into local governmental and industrial laboratories.

Waterloo

The University of Waterloo Faculty of Engineering is giving serious consideration to the recommendation contained in the Lapp Report (11:6 p.88) concerning the establishment of an independent technical university in association with the University of Waterloo. The Waterloo study group is not investigating independence "per se" but rather is seeking to identify the special needs of engineering in that university and to identify mechanisms for promoting a distinctive activity. The result will be an articulation of the pros and cons of three alternatives: complete autonomy, limited autonomy or the status quo. Whatever the choice, CODE hopes that there will emerge an understanding of the special role in the province of engineering education at Waterloo.

(10) CODE endorses the policy and procedure proposed by Waterloo for responding to the proposal that there be formed an independent technical University. In due course CODE expects to receive the findings of the Waterloo study group, and to make its own recommendations.

Western

(11) CODE takes note with approval of the discussions and studies relating to environmental engineering taking place at Western.

"Ring of Iron" recommends that the Faculty of Engineering Science

at Western undertake a special role in environmental engineering. CODE is informed that Western is developing an interpretation of this recommendation and its implications for graduate and undergraduate programs. (A special report on the educational operations at Western is in preparation by Dr. Arthur Porter. The implications of this study for the Faculty of Engineering Science will also have to be taken into consideration in the evolution of its special role.) The Faculty has already initiated an "environmental thrust" for its undergraduate students through the first of a new sequence of courses relating man and his environment, as an alternative to traditional humanities and social sciences. We note that Western intends to continue its present undergraduate program involving an engineering core and five options of specialization (chemical and biochemical, civil, electrical, materials and mechanical).

CODE is also informed that in its graduate program, Western is identifying areas of special emphasis, using the methods recommended in this report; one of these will continue to be environmental engineering, as recommended by "Ring of Iron".

Windsor

(12) CODE accepts Windsor's intent to emphasize 'liberal engineering' and 'design', in its undergraduate programs. Special roles in the graduate area will be determined by the methods and procedures outlined in this report. Windsor sees 'liberal engineering' as a vehicle for developing a keen social awareness through communication and and interaction between engineering and social science. Following Rosenstein's interpretation, Windsor equates 'design' with the professional decision-making process.

McMaster, Queen's, Toronto, Waterloo

(13) All schools in this system including McMaster, Queen's, Toronto and Waterloo for which "Ring of Iron" recommends a full spectrum of progr will be included within the plan for the identification and establishment of special roles. Existing as well as new programs will be subject to evaluation.

THE SYSTEM BOUNDARIES

CODE is concerned with the extent to which institutions other than the eleven specifically included in the Report impinge upon the 'system'. The system is 'bounded' on the one hand by programs in pure and applied science that have no professional engineering overtones, and on the other by programs in technology at Ryerson and the CAAT's. The special position of RMC has also to be considered, since it offers professional engineering training, but is outside the system for political reasons.

(14) We concur with "Ring of Iron" recommendation (11:16) that York University not develop any programs in Engineering and with recommendation (11:15) that no further engineering schools be established prior to 1980.

No need has been established for a new Engineering program at York University nor at any other. The existing schools can and should develop to accommodate all potential engineering students in this decade.

(15) Since RMC is a part of the national system of military colleges and not a Provincial institution, we consider it to be outside the Provincial system of engineering schools.

We note, however, that RMC is an affiliate of COU, and that Ontario students go there to study engineering. We understand that recommendation (11:19) of "Ring of Iron" concerning liberal engineering at RMC is under active consideration. In the process of preparing a new 4 year curriculum, RMC is moving in the direction recommended by placing greater emphasis on the applied humanities. However, in view

of the continuing special needs of the Canadian Armed Forces, it is intended to continue for the present with the traditionally designated courses.

(16) CODE recommends that COU, in consultation with DUA if deemed advisable, designate an appropriate consultative mechanism to ensure an immediate review and planning assessment of the Engineering Technology degree programs in relationship to the existing university engineering programs.

Should the proposed B.Tech. programs at Ryerson be professionally recognized (for registration in the engineering profession) and be intended in the future to serve a substantial part of Ryerson's traditional enrolment in engineering technologies, two significant consequences would in our view ensue.

(i) A transformation of Ryerson's important and highly successful technology programs into professional engineering programs may leave a serious gap both in leadership and manpower supply within the educational spectrum of the province at a time when there is a general need to bring the supply of technologists into better balance with that of professional engineers.

(ii) Were Ryerson to become in effect a second professional engineering school in metropolitan Toronto in the 1970's, the recommendations of "Ring of Iron" and the system planning now under way in response to it would largely be invalidated. In particular, the expected migration of students from Metropolitan Toronto to the other schools in Southern Ontario may not in fact take place, and the total

numbers in the system may have to be increased.

CODE is concerned about the interpretation of the statement on p. 81 of "Ring of Iron": "Therefore, such programs as those proposed for Lakehead and planned by Ryerson should develop without competition." We would not wish this to be taken to mean that graduates of CAAT's would not be admitted to engineering programs in other Universities on an individual merit basis, as is now the case. We do support the interpretation that in this decade Lakehead and Ryerson be developed without competition from the emergence of new degree programs in the CAAT's, but that Ryerson's development be not as an engineering school in the university School-of-Engineering tradition and Lakehead's development be in accordance with the special role indicated elsewhere.

In view of CODE's support for the statement in "Ring of Iron" that no new engineering schools be developed in this decade, CODE feels that immediate further detailed consideration must be given to the development of the B.Tech. programs at Ryerson and their relationship to the Engineering education system.

ENROLMENT

CODE notes that Canadian Council of Professional Engineers is in the process of establishing for a trial period of 3 years a Canadian Engineering Manpower Council. CEMC, once established, will generate annual enrolment and graduation statistics, an annual placement survey, a manpower resources survey every three years, and a demand study every other year.

(17) CODE fully supports the proposal for the establishment of a National Engineering Manpower Council. We expect to be asked by it to assist with the input of data from the Ontario Engineering Faculties, and to advise on the operations of the Council. In this matter CODE looks to COU for administrative assistance.

Quite apart from professional manpower needs, CODE will also take cognizance of the role of undergraduate engineering education as general education providing suitable preparation for many occupations including positions in business, commerce, industry, government, and other professions.

Undergraduate

Total Enrolment

(18) We recommend that, in conjunction with the monitoring system recommended below, five year targets for the total system enrolment be determined and reviewed annually, and that initially the total enrolment as projected in "Ring of Iron" be accepted.

In general the individual schools appear to accept the total enrolment projection presented in "Ring of Iron" and envision no apparent difficulty for the system in adequately handling the

numbers involved. We look on a freshman intake of 4000 by 1980 as an undoubted maximum. Strong criticism has been voiced of using a modified admission system merely to attain such an enrolment.

Component Enrolments

(19) We recommend that freshman intake be accepted as the control factor for the enrolment in individual schools, that the maximum freshman intakes recommended in "Ring of Iron" be accepted, and that unless agreement exists among all engineering schools in the system, such maximum recommended freshman enrolments not be exceeded.

It is understood, as part of this recommendation, that the maximum for Toronto be acepted as 10% above the "Ring of Iron" figure, and that for Waterloo 3% above. The special case for Laurentian is dealt with in Section III.

Importantly, it would appear that most schools are prepared to accept the individual maximum freshman intakes recommended. McMaster and Queen's both express concern about the problems of growth to their recommended maximum. In general there exists adequate reserve capacity to accommodate expected increases. Toronto wishes to retain its present level, 10% above that recommended, and Waterloo plans are apparently based on a figure 3% higher. CODE recognizes that other factors, such as advanced admissions, affect total undergraduate enrolment and that such totals may fluctuate in the presence of constant admissions.

Monitoring the System

(20) CODE recommends that, with the assistance and facilities of COU, it immediately be authorized to initiate a continuing

quantitative appraisal of the dimensions of the engineering education system.

With regard to undergraduate enrolment this means that specific engineering enrolment statistics, probably in conjunction with the Ontario Universities Council on Admissions and the proposed Admissions Clearing House, be regularly assembled. Five year enrolment forecasts, based on individual school submissions, should be prepared annually. Such forecasts should then bear recommendations covering significant deviations from planned enrolment patterns. The following parameters must be considered in such monitoring and analysis:

- Available capacity of physical facilities and staff.
- Student mobility, in particular as it relates to availability of undergraduate places in schools within commuting distance.
- Full utilization of the proposed Admissions Clearing House for best utilization of existing undergraduate engineering places in various engineering disciplines.
- Estimation of the impact of transfer from CAAT programs, and of degree programs at Ryerson.
- Estimation of the potential impact of the applied science programs outside the system of Engineering Schools.
- Interaction with the profession. The universities must maintain the essential element of independent control of entry into undergraduate programs; but we accept the responsibility of encouraging the profession to delineate as clearly and continuously as possible the needs of the profession.

Graduate

(21) We recommend that there should be no limitation of numbers

imposed on part-time graduate students.

These are invariably persons already employed, and are frequently a number of years beyond the Bachelors degree. Part-time enrolment will reflect the demand and numbers below will refer to full-time enrolment.

(22) We agree with the statement in "Ring of Iron" (p. 15) that the number of full-time Masters students should increase naturally to a maximum of 1850 by 1980.

However, we would wish to keep the target figure of 1850 under continual review.

(23) CODE records its concern for the number of graduate students in the system relative to the demand, the cost of graduate study, especially at the Doctorate level, and implied criticism concerning the large number of non-Canadian students.

CODE would with the support of COU establish and maintain an information data bank containing such information as the numbers of students at masters and doctoral level, full-time or part-time, by area of study and country of origin. This data will provide a basis of periodic review by Universities, Government and Industry, and this review should be designed to encourage a reasonable balance between the capabilities and needs of the universities and the needs of society. This would include assessment of needs for graduates by discipline, and identification of fields where there are shortages and oversupply.

(24) We do not accept the recommendation that PhD programs be eliminated at Guelph, Western, and Windsor. The future of these, as of all PhD programs in the system, should be determined on the basis

of academic quality and demand.

While CODE supports the concept that, in areas where there is clearly no market demand, graduate studies in Engineering may be disengaged from related research.* CODE does not agree that the reduction in overall PhD enrolment, which it supports, should be achieved in part by eliminating PhD studies at any particular university. "Ring of Iron", while presenting a rational argument for the imposition of an overall quota of 450 PhD's in the system, gives no such rational argument for the distribution of the 450 places within the system. No areas in which PhD studies should be discontinued have been identified, either on the basis of a lack of market demand, or on the basis of inferior academic standards. CODE believes that at Guelph, Western and Windsor there are highly qualified faculty and special facilities devoted to well established research programs and associated graduate studies in areas for which there exists a demand for PhD's.

CODE therefore sees no reason at this time to impose a blanket disengagement of PhD studies from all research being carried out at any one university.

(25) CODE supports the reduction of the total full-time PhD enrolment in the system and accepts the level of 450 as being reasonable for the year 1974-75, having regard for the current utilization of PhD graduates.

We understand clearly that a reduction of enrolment in the system implies a reduction of enrolment in each institution and we intend to

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* It is understood that 'related research' would be continued only on the basis of acceptable academic quality.

effect this. However we do not accept the imposition of an arbitrary quota system, which although intended to be temporary, may well acquire unreasonable rigidity to the detriment of individual students, institutions and the public.

We have agreed to work with OCGS, with the discipline groups and with professional bodies outside the universities system to ensure that new PhD registrations are adjusted downwards on the basis of agreed standards and conditions which will give consideration to

i) improved academic ability and motivation of the students selected for all programs

ii) control of the proportion of non-Canadian students, selecting those who show a real promise that they will return better qualified to their own countries or will contribute a special quality to the Canadian scene

iii) a demonstrated need for the program, as indicated by employment opportunities

iv) the priority, strength and cost of current PhD programs relative to others in the institution and to similar ones in the Province.

In addition, the information bank and consultations proposed in recommendation (23), together with future academic assessments, will provide a basis for sensible on-going criticism of the planning decisions of individual institutions.

COST ANALYSIS

An important component of the study of Engineering education in Ontario reported on in the "Ring of Iron" was an analysis of costs in the Province's Engineering schools. This cost study has been described in some detail in appendix H of the Report and in COU Report No. 70-3.

As there has been considerable concern over the apportionment of costs between the graduate and undergraduate areas and the comparative position of the various schools, CODE has considered both the method used in the Study and other methods in an effort to determine whether the unit costs arrived at in the Study and the resulting analysis can be regarded as authoritative. As will be
(26) detailed below, our conclusion is that the results of the cost analysis undertaken as part of the study are unfortunately misleading, and we recommend that all possible action be taken to mitigate the consequences.

The first matter of concern is the basic accuracy of the data base and related assumptions. Possible sources of error are discussed in the "Ring of Iron" at some length and it has become evident that some inconsistency surrounds the assignment of "overhead" items such as workshops, library, computer services and so on. For example, Lakehead considers their actual unit costs to be almost 24% lower. On the other hand, at Guelph activities funded separately by the Ontario Department of Agriculture and Food produce an atypical costing situation and they provisionally estimate their unit costs to be about 17% higher than given in the Study. These, and other
(27) examples of error or doubt prompt CODE to recommend that cost

information provided in the "Ring of Iron" should be viewed as approximate so that gross differences only can be regarded as of any significance. In future, such cost studies as are deemed appropriate should be conducted on a university and system-wide basis following an agreed upon format.

A matter of central concern to CODE has been the apportionment of cost between the undergraduate and graduate areas and, in particular, Figure H-2 on page 134 of the "Ring of Iron" which shows both the assumed level of undergraduate costs and a relationship between costs and the size of the school. The analysis undertaken here concentrates on this problem.

The presentation of the basic cost data, which avoids entirely the problem of apportionment, is shown in Figure 1.* The overall budget and enrolment figures of each Faculty defines the particular straight line given by the following formula:

$$B = \alpha N_u + \beta N_g$$

where
B = total faculty budget
N_u = undergraduate enrolment
N_g = graduate enrolment
α = unit undergraduate cost
β = unit graduate cost

Clearly, any method for dividing costs must yield a point on this straight line. An alternate approach to representing the same information is to plot the undergraduate unit cost against the ratio of graduate to undergraduate unit cost as shown in Figure 2 (taken from the Toronto response).

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* The data used in the "Ring of Iron" has been used in this analysis. Only the Waterloo data has been modified from that in Figure H-2 where the number of undergraduates shown was incorrect.

Figure 1 directly suggests a rather obvious interpretation, illustrated in Figure 3. The two straight lines corresponding to graduate to undergraduate unit cost ratios of two to three suggest that there are two groups of Engineering faculties. One group could be said to pursue internal policies yielding a two to one cost ratio; the other group a three to one ratio. This in turn leads to a division of the schools into a "high cost" group and a "low cost" group.

The "Ring of Iron" analysis yielded the points shown in Figure 4. As this analysis was dependent upon the determination of a factor, K, by statistical analysis, and since two K values were discussed in the Report, a sensitivity analysis seemed appropriate. This is also illustrated in Figure 4, the extreme values of K being 50 and 190, and in Table I a wide variation in the unit costs is shown.

Appendix B outlines yet another approach to the sensitivity of the regression analysis. In this case, three different analyses were applied to the data available for each faculty. The results given in Section I of the Appendix illustrate that the correlation obtained is almost completely independent of the value of the relative weighting. This strongly suggests that little significance can be attached to the peaking of these factors.

A further approach to the determination of an appropriate K factor, and thereby an appropriate division of costs between the undergraduate and graduate areas, is the examination of the implication of the K factor on the workload of an individual faculty member. Section II of the Appendix outlines such a critique and shows that the "Ring of Iron" analysis implies:

one graduate student supervised = two undergraduate courses lectured

This suggests that a K factor of 150 is considerably too large. By comparison, it has been reported that policy at the University of Manitoba sets the supervision of 6 graduate students as an equivalent full-time load. Application of the above formula to this gives 12 undergraduate courses lectured as a full load!

Section III of Appendix B outlines a possible approach to calculating the marginal costs associated with the enrolment of graduate students. Such an approach necessitates an assumption regarding appropriate faculty loading for a purely undergraduate school and for comparative purposes staff contact, times of 18, 12 and 9 hours per week are proposed. The resulting table of marginal costs suggests again that the heavy weighting taken in the Study analysis is not valid.

The shape of the curve in Figure H-2 which leads to the concept of an optimum sized school in the vicinity of 900 undergraduates has been subject to some study by Toronto and they have reported that only a straight line fit may be taken as statistically valid.

In conclusion, as a consequence of this study the following is apparent that:

i) The cost apportionment is very sensitive to the choice of K and the statistical basis for the choice of K = 150 is weak.

ii) The critical review of the faculty loading implications of K = 150 shows that this value is too high.

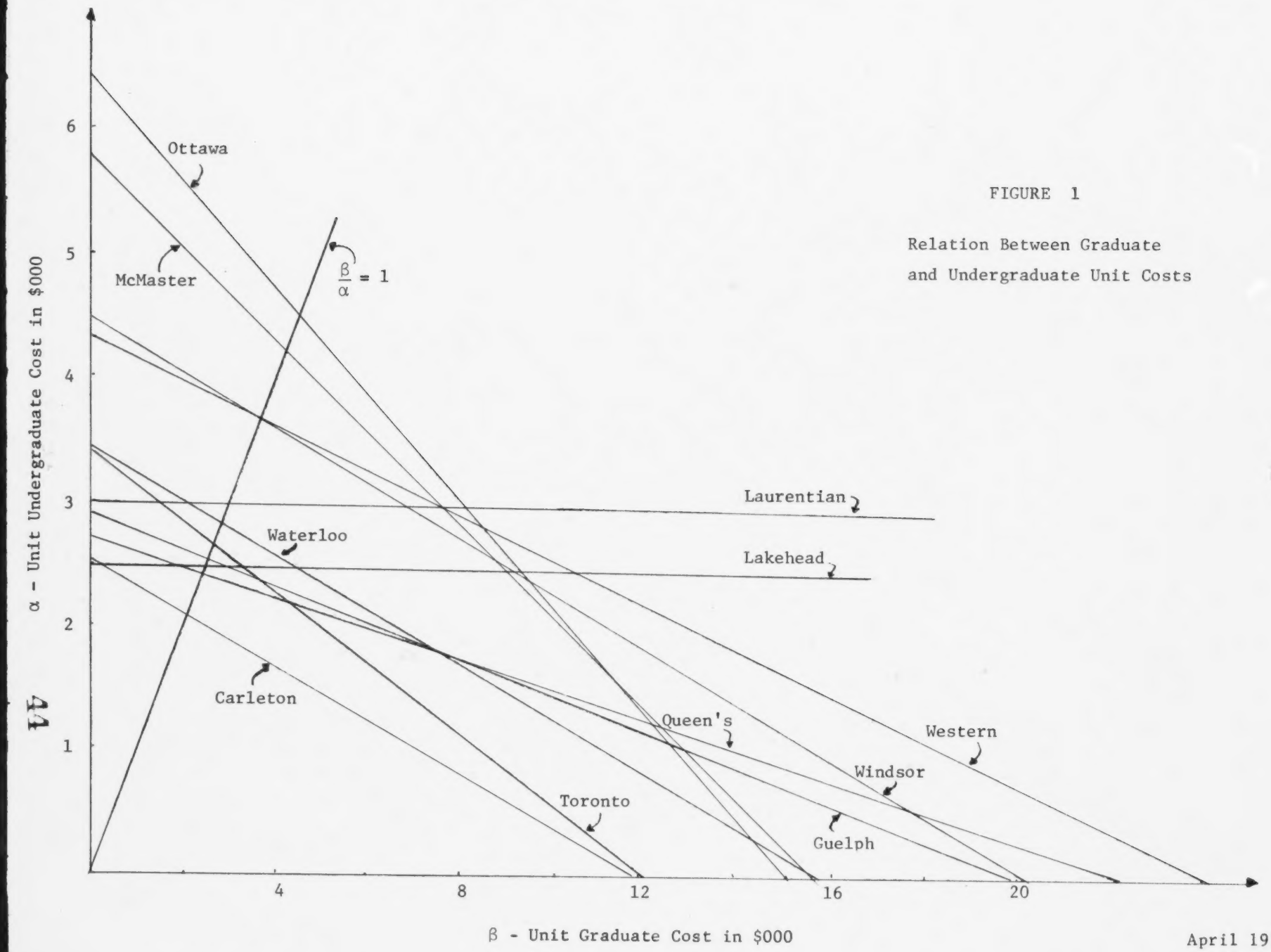
iii) Other approaches to the problem indicate higher undergraduate costs and lower graduate costs than the Report.

iv) There is no evidence to imply a causal relationship between unit undergraduate costs and enrolment; there is evidence that the schools may be grouped in terms of average costs.

(28) CODE affirms that the apportionment of resources between the graduate and undergraduate areas is essentially a policy consideration at each school and that the only general matter of importance is the total budget. We would be distressed if 'economic viability' were to become the decisive influence in the development of engineering programs.

FIGURE 1

Relation Between Graduate
and Undergraduate Unit Costs



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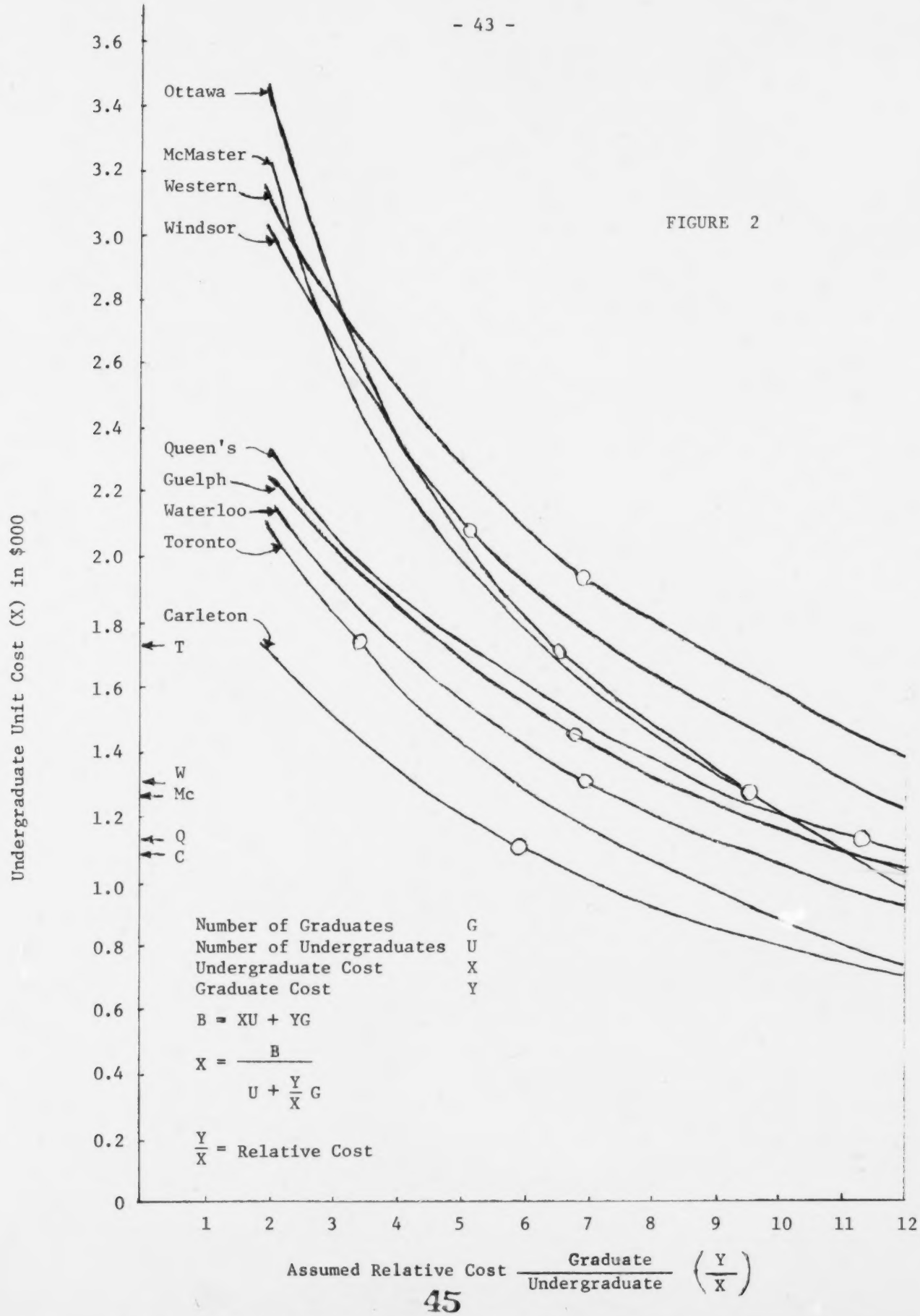
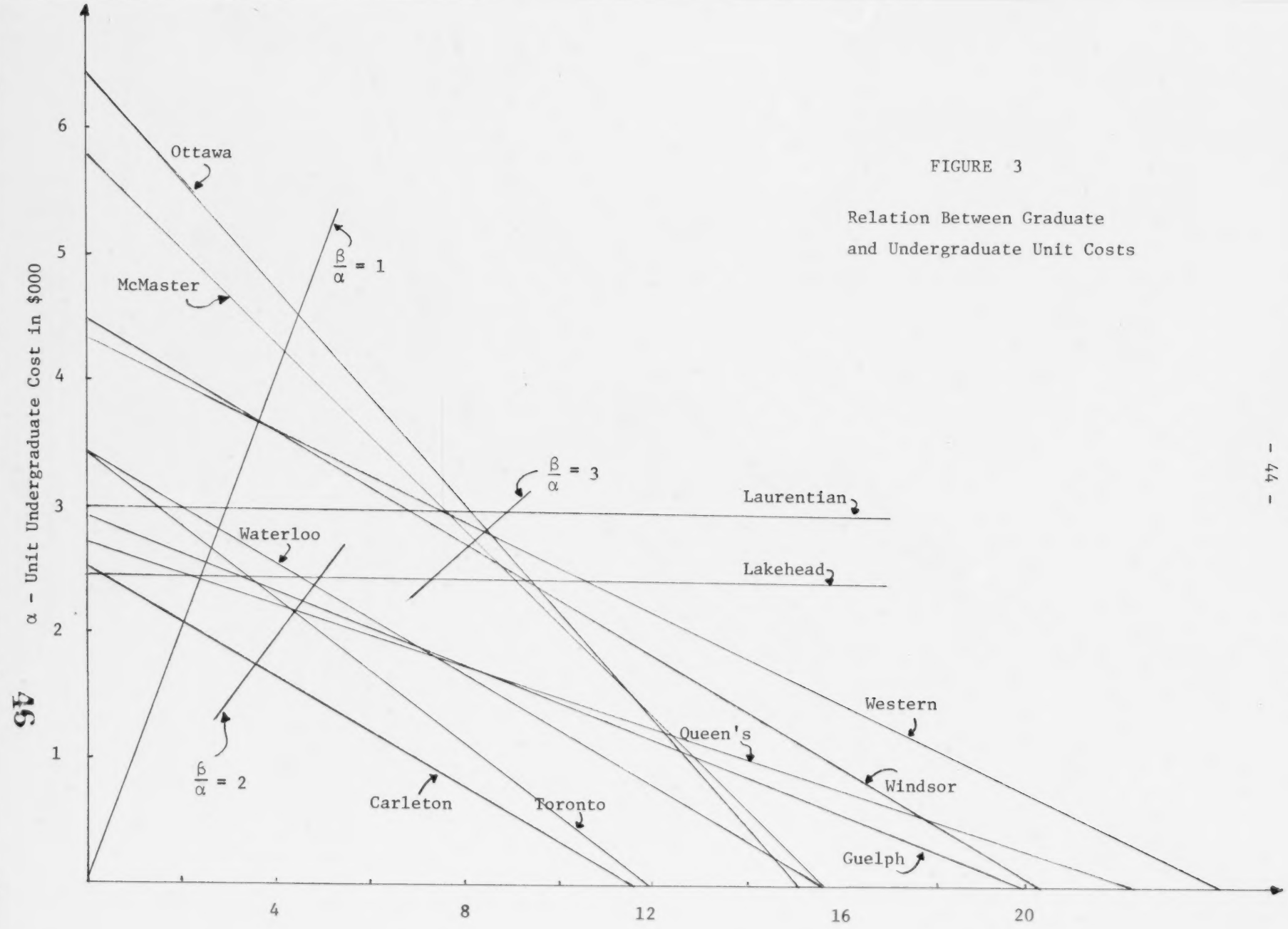

Undergraduate Unit Cost (X) in $000
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
Ottawa
McMaster
Western
Windsor
Queen's
Guelph
Waterloo
Toronto
Carleton
T
W
Mc
Q
C
Number of Graduates G
Number of Undergraduates U
Undergraduate Cost X
Graduate Cost Y
B = XU + YG
X = B / (U + Y/X G)
Y/X = Relative Cost
1
2
3
4
5
6
7
8
9
10
11
12
Assumed Relative Cost Graduate / Undergraduate (Y/X)

FIGURE 2

FIGURE 3

Relation Between Graduate
and Undergraduate Unit Costs



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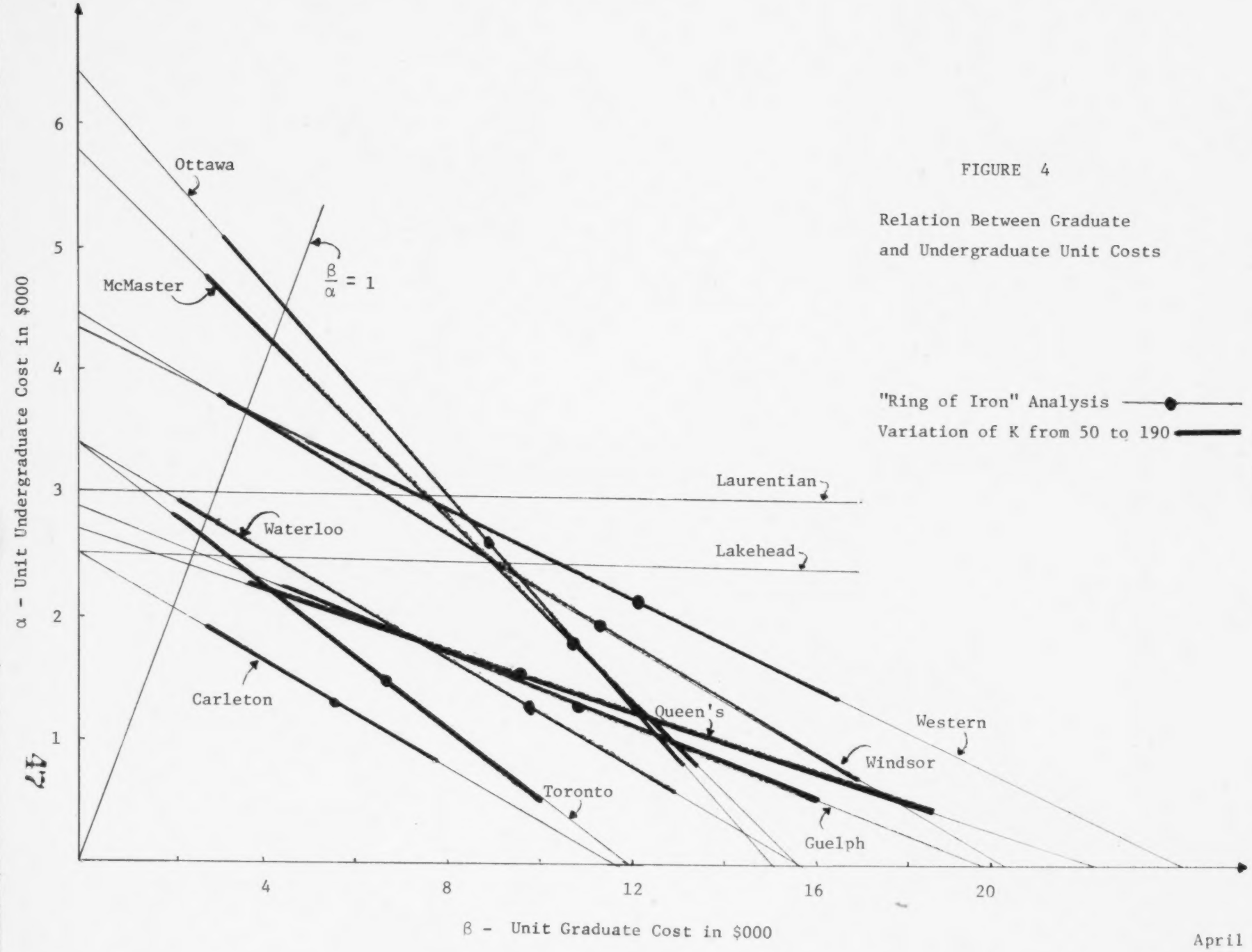

FIGURE 4

Relation Between Graduate
and Undergraduate Unit Costs

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TABLE I

Dependence of Graduate Costs on Variation of the K - Factor

UNIVERSITY	GRADUATE COSTS			
	K = 50	K = 115	K = 150	K = 190
Carleton	2177	5006	6530	8271
Guelph	3333	7667	10,000	12,667
McMaster	4013	9231	12,040	15,251
Ottawa	3690	8487	11,070	14,022
Queen's	4253	9783	12,760	16,163
Toronto	1967	4523	5900	7473
Waterloo	3123	7184	9370	11,869
Western	4397	10,112	13,190	16,707
Windsor	3533	8127	10,600	13,427

OTHER RECOMMENDATIONS

Admissions

(29) We propose that regular consultation be established between CODE and the Ontario Department of Education.

The observation of the Report (p. 6) concerning lack of communication between CODE and the Department of Education is accepted. CODE will establish a subcommittee on admission standards whose chairman will communicate with the appropriate representatives of the Department, of the Colleges of Education, and students in the schools, on the subject of technology and engineering.

(30) We accept an amended version of recommendation (2:1) of "Ring of Iron", concerning admissions, to read:

> "Beyond senior mathematics, the secondary school Honours Graduation Diploma should be the basic requirement, set at a level of performance decided upon by the faculties of engineering, with assured aptitude for and knowledge of the physical sciences."

"Ring of Iron" drew attention (p.7) to the trend toward the use of the credit system in Ontario secondary schools and to the declining proportion of students electing to study physics and chemistry. It suggests that, if present trends in the secondary schools continue, in order to meet the probable demand for engineers (1500 to 2500 B.Sc. & M.Sc. per year plus 125 PhD) (see p.55) the admissions requirements will have to be changed. Many of the universities are concerned about a possible deterioration in student preparation with consequent obstacles for otherwise good

students or a lowering of standards. "Ring of Iron" recognized that without physics and chemistry the students' chances of success are in jeopardy. (p. 7)

The Profession

(31) CODE endorses with reservations recommendation (7:1) of "Ring of Iron", that part-time undergraduate studies be an alternative path to a bachelor's degree and ultimately replace the present APEO examinations.

The universities recognize that providing an alternative to the present full-time day programs has many attractions for the aspirant to professional registration. However, we appreciate that there are difficulties in implementing recommendation (7:1). Out-of-hours instruction on an extensive basis for any university is inevitably a very costly undertaking. The need for it has not in our opinion been established for all the Ontario Universities but depends on local conditions.

The APEO has established an Admission Standards Committee, involving CODE, the CAATS, and Ryerson which is to study alternate routes into the profession involving an acceptable degree in Engineering.

(32) CODE endorses recommendation (7:5) of "Ring of Iron" that those engineers engaged in teaching in Ontario should be registered members of the profession.

This will not necessarily include all members of engineering faculties, nor indeed all engineers engaged in teaching. CODE endorses the principle that the teaching of engineering is a part of the profession of engineering.

(33) CODE is prepared to enter into discussions with the APEO on whether and how the universities might contribute to requalification of professional engineers.

It is properly the responsibility of the profession to articulate clearly the objectives to be achieved in terms of the performance of candidates for requalification. It is expected that APEO will take the initiative in this matter.

(34) CODE is prepared to facilitate accreditation of undergraduate programs by the Canadian Accreditation Board through provision of the required quantitative data.

Professors

(35) CODE is in general agreement with recommendation (6:1) of "Ring of Iron" concerning cross-appointment of staff between university, industry and government.

There is within our universities and industry a large and diverse pool of knowledge and expertise which should be utilized in meeting the present social needs of the larger community. It is important to cultivate a higher degree of university/industry interaction through the medium of the engineering school. Members of engineering faculties have a special obligation to keep abreast of the changing scene and of techniques being developed in industry, in addition to their other responsibilities in teaching and research. One of the many ways of accomplishing this is by cross-appointment of staff between university and industry.

Undergraduate Environment

(36) CODE recommends that (3:1) of "Ring of Iron" be modified and

extended to read "Innovative opportunity, such as in the form of design should be brought into all years of engineering programs, despite the elementary character of the design examples. The gain in motivation and morale would amply repay the expenditure of time."

There are other ways besides design for exposing students to a professional environment. The recognition of real problems may come from analysis of a situation as well as from a design process. The need for this improvement in programs may exist in higher years as well as in first year. This recommendation is already being implemented.

(37) CODE shares the view recorded on p. 9 of "Ring of Iron" concerning bridges between engineering and the social sciences and humanities.

We would encourage initiatives that would provide meaningful exposure of students in social sciences and humanities to the basic concepts and practices of engineering.

(38) CODE endorses the suggestion on p. 11 of "Ring of Iron" that engineering schools should promote student exchanges between Ontario and Quebec (such as that between Western and Laval) in the interest of fostering Canadian unity. It also recommends that more recognition be given to the special problems of bilingual institutions.

(39) CODE endorses recommendations (3:2) and (3:4) of "Ring of Iron" concerning teaching laboratories and student participation on curriculum committees.

These recommendations are already being implemented.

(40) CODE endorses recommendation (3:3) calling for the establishment of a depreciation policy with respect to engineering laboratory equipment.

(41) In view of the financial implications of a reduction in PhD enrolment, of some disengagement of research from graduate studies, and of the institution of a depreciation policy with respect to laboratory equipment, CODE supports a recasting of the present BIU formula. This is in agreement with recommendation (10:1) of "Ring of Iron".

APPENDIX A

A PROPOSED MECHANISM FOR EVALUATING ENGINEERING PROGRAMS

(See Recommendation (4))

I. CURRENT STATUS

OCGS Appraisals Committee

Under its By-Law #2, approved by CPUO, the Ontario Council of Graduate Schools, effective January 1, 1967, established a standing committee on Appraisal of Graduate Degree Programs. This Appraisals Committee has a detailed procedure, approved by OCGS, and followed for the appraisal of new programs at both the PhD and Masters level. The appraisal, following voluntary submission of program proposals, embraces only those factors required to ensure establishment of academically sound programs. The history of this academic appraisal system for its first three years of operation has been recently reported.

OCGS Advisory Committee on Academic Planning (ACAP)

As directed by the Council of Ontario Universities, OCGS, under its By-Law #3, recently established ACAP to assist groups representing the various academic disciplines to promote the rationalization of graduate studies in their respective areas of study, to advise OCGS on the implementation of provincial planning of graduate development, to recommend on the carrying out of planning assessments of disciplines or of groups of related disciplines, and to supervise the conduct of such assessments. The "Ring of Iron" may be considered such an assessment. ACAP reports directly to COU the results of planning assessments, including consultants' reports, any comments on these reports (from discipline groups, universities, etc.) and its recommendations for action.

There is no overlap in membership between the Appraisals Committee and ACAP; it is considered essential that the appraisal function be, and be seen to be, completely separate from planning.

CODE

CODE has accepted in its response the responsibility for full involvement in a system or systems of evaluation of both graduate and undergraduate programs, inclusive of both current and new programs. It envisions its involvement in fullest co-operation with other authorities or groups whose responsibility or authority is already understood or accepted. Specifically, CODE seeks its involvement taking into account the three levels of evaluation which we define generally as follows:

Appraisal - relates to academic appraisal relative to all factors ensuring acceptable academic quality. The OCGS appraisal of new graduate programs is precisely this.

Accreditation - relates to formal acceptance and approval, by the profession, of undergraduate programs, graduates from which, after suitable professional experience, are eligible for professional registration. The Canadian Accreditation Board (CAB) is now moving to a complete nation-wide re-accreditation of undergraduate programs. CODE projects involvement with CAB in such accreditation reviews, so that assessment can be achieved simultaneously, (cf. Recommendation 7:3, "Ring of Iron").

Assessment - relates to an evaluation inclusive of academic quality, but with the additional correlates of need, demand, enrolment potential and other elements of economic viability. This type of assessment reflects the responsibility of ACAP in the graduate area.

CODE has asserted, in its response, the need for such assessment as a means of continuing to define and develop the concept of special roles. In its view the requirement is for such assessment at both undergraduate and graduate levels. The following matrix indicates, simplistically, the status of responsibility for such evaluations, and the sectors in which CODE seeks involvement(*)

Evaluation Mode / Level	APPRAISAL	ACCREDITATION	ASSESSMENT
Undergrad.	*	APEO → CAB *	*
Graduate	OCGS		ACAP (OCGS) *

II. PROPOSED ORGANIZATION

In order to initiate and participate in the evaluations described above, CODE proposes to adopt a mechanism as outlined below, the organizational and procedural refinements of which will be completed by January 1972.

1. CODE will establish as a standing committee, a committee on Program Evaluation. This standing committee will be elected by CODE, will consist of five members of CODE or their delegates (as accepted by CODE), and will be constituted both for continuity and rotation of membership.

i) to co-ordinate CAB re-accreditation requests, using COU data-gathering services and participating in the qualitative assessments required.

ii) to define a precise link with ACAP, in consultation with OCGS and COU, so that an integrated involvement is achieved for planning assessment of engineering programs or disciplines at the graduate level.

iii) to develop through the linkage with ACAP, participation in the review of planning assessment reports on graduate programs.

iv) to develop appropriate procedures for appraisal and assessment of undergraduate program.

2. The committee will establish its procedures and formal relationships with other bodies, subject to approval by CODE.

3. Committee recommendations will be forwarded to CODE, and when appropriate, simultaneously to other bodies for information. CODE recommendations will be transmitted to COU, and, dependent on the linkage established with ACAP and OCGS, to those groups also.

4. In the graduate area the definitions of department and programs will be those used by OCGS and its appraisals committee.

III. PROPOSED PROCEDURES

Procedures will be developed by the Committee on Program Evaluation for submission to and approval by CODE. They will include specification of parameters, correlates and data requirements for the various functions. Procedures will therefore include the listing of quantitative information required for assessments, the listing of qualitative information or judgmental areas required for assessments, and the development of scaling factors in each case.

Procedures will be tied in essence to the conept of use of expert consultants for assessments. The organizational relationships with CAB, OCGS and ACAP must be developed so that CODE's committee on program evaluation will, for example, participate in the selection of consultants and in the receipt and consideration of their reports.

APPENDIX B

SUPPORTING DATA FOR COST ANALYSIS

I. K FACTOR SENSITIVITY

The object of this appendix is to report the findings on the sensitivity of the undergraduate-graduate weighting on the correlation between cost and the enrolment based on this weighting scheme.

The analysis was performed three times using different sets of data. The first analysis involes the regression of total cost including overhead on undergraduate and graduate enrolment by university, using the data as contained in the "Ring of Iron". The second analysis uses the same method, but with actual departmental expenses only and slightly modified enrolment figures. The third analysis involves the regression of individual departmental expenses on staff contact hours and the number of graduate students by individual academic departments.

In all three cases, the relative weighting of the two independent variables was determined, and the correlation coefficient calculated. To determine the sensitivity of the correlation coefficient on this relative weighting, various values were taken and the correlations calculated.

Analysis I

Total Cost = y

Undergraduate Enrolment = x_1

Graduate Enrolment = x_2

Least Squares fit

$$\hat{y} = 498{,}809.80 + 1531.62 \left[x_1 + 4.02x_2\right]$$

Analysis II

Total Cost = y

Undergraduate Enrolment = x_1

Graduate Enrolment = x_2

Least Squares fit

$$\hat{y} = 505,568.42 + 1,526.23 \left[x_1 + 1.08x_2\right]$$

Let $x(k) = x_1 + k \cdot x_2$

Correlation between y and x(k) as a function of k:

k	Correlation: Analysis I	Correlation: Analysis II
0	.968	.979
0.5	.971	.983
1.08	.977	.986
3	.988	.985
4.02	.988	.983
5	.988	.982
8	.986	.977
10	.984	.974
16	.980	.969
...	.914	.953

Analysis III

Academic Salaries = y

Staff Contact Hours = x_1

Graduate Students = x_2

Least Squares fit

$$\hat{y} = 72{,}909.37974 + 17.65 \left[x_1 + 165.32\ x_2 \right]$$

Defining $x(k) = x_1 + k.x_2$ as before, the correlation between y and x(k) as a function of k:

k	Correlation
0	.889
50	.918
100	.927
150	.930
165.32	.930
180	.930
200	.929
∞	.895

The three analyses all show that the correlation is quite insensitive to the relative weightings of undergraduate and graduate students. Although the 'optimum' relative weights change from Analysis I to Analysis II, the correlations remain essentially the same. The 'optimum' k value of 165 with correlation of .930 is in essential agreement with the "Ring of Iron".

II. CRITIQUE OF K FACTOR

From page 128 of the "Ring of Iron"

total departmental teaching equivalents = total department contact hours
+ K x number of graduate students assigned to the department

If K = 150 and this is applied to an individual faculty member, then

1 graduate student supervised for a calendar year = 150 hours

2 three hours per week lecture courses for an academic year = 6 x 25
= 150 hours

so

1 graduate student supervised = 2 lecture courses taught

or

1 graduate student supervised = 6 hours per week teaching contact

This result does not seem to be in good accord with realistic teaching loads. Consider the following possible, but heavy, teaching loads:

Professor A - 6 hours lecturing, 3 hours laboratory supervision
3 graduate students to supervise

Professor B - 15 hours teaching and laboratory contact time

This implies that

1 graduate student supervised = 2 hours per week teaching contact

which is considerably different from the Report assumption,

This analysis is hypothetical, and but one of a number of possible reasonable situations; these analyses have suggested that K = 150 would not be substantiated in practice.

III. MARGINAL GRADUATE COST ANALYSIS

The objective of this analysis is to determine the graduate costs on the basis of additional faculty effort above that required to operate the undergraduate program alone.

First, from the Report data, form:

$$\text{average weekly contact hours per faculty member} = \frac{\text{staff contact hours}}{\text{no. of faculty x 25}} = H_u$$

In an 'all undergraduate' school, take H_t to represent the average faculty contact hours per week. (This might be 18, 12, or 9 hours per week for example.) Then the equivalent contact hours per faculty member for graduate supervision and teaching would be

$$H_g = H_t - H_u$$

The total faculty budget, B, could then be divided:

$$B = B_o + \frac{H_u}{H_t} B_i + \frac{H_g}{H_t} B_i$$

where B_o is the portion of the total budget B associated with the teaching of undergraduate engineering by other than engineering departments. (A similar graduate amount is assumed to be negligible.) Then the marginal graduate unit cost is

$$\beta = \frac{(H_t - H_u)}{H_t} \frac{B_i}{N_g}$$

Application of this method to the "Ring of Iron" data yields:

MARGINAL COST ANALYSIS

UNIVERSITY	STAFF CONTACT HOURS	FTE STAFF	AVERAGE WEEKLY CONTACT HOURS	COST PER GRADUATE STUDENT HT = 9	HT = 12	HT = 18
Carleton	14,949	35.0	17.08	-*	-	577
Guelph	4,370	15.4	11.35	-	1078	7351
McMaster	10,577	61.5	6.88	3643	6598	9553
Ottawa	10,751	39.0	11.03	-	1821	6160
Queen's	17,479	87.5	7.99	2528	7527	12,526
Toronto	84,857	188.0	18.05	-	-	-
Waterloo	49,075	159.2	12.33	-	-	4760
Western	11,158	40.0	11.16	-	1821	9888
Windsor	13,043	45.4	11.49	-	765	6511

* no entry indicates negative marginal cost

OCGS Report to COU on "Ring of Iron"

The Lapp Committee report on Engineering Education in Ontario was referred by CPUO to both CODE and OCGS. In OCGS it stood referred to ACAP. ACAP has considered the recommendations which bear directly on graduate studies and has reported to OCGS as follows. OCGS has approved these recommendations and in turn recommends that COU accept them.

The Lapp Committee's report contains fifteen recommendations dealing with graduate affairs [(4:1), (4:2), (5:1), (10:1), (9:1), (11:1), (11:3), (11:5), (11:7) - (11:12) and (11:15)] of which the last eleven deal with graduate enrolment. Recommendation (1:1) taken together with Table 9-10 gives the report's recommendation for overall graduate enrolment year by year, and the recommendations of Chapter 11 apportion this enrolment amongst universities giving specific numbers for 1973-74. In some cases (Carleton-Ottawa, Western and Windsor) recommendations are made as to the fields of graduate research to be offered.

ACAP is aware that the Lapp study was carried out under the guidance of a liaison committee representing CPUO and CODE, that the study group devoted a year to the project, and that it produced three research studies on enrolment projections, employment projections, and cost analysis. ACAP assumes that the Lapp committee has been led to its recommendations concerning graduate enrolment after careful study of employment and enrolment prospects for engineering and of the specific characteristics and potential of each university. In any situation as complicated as the provincial arrangements for engineering education, there will be details seen differently by different persons, but ACAP perceives no basis for disagreement with the general tenor or recommendations of the report in the graduate area. In particular, any manpower data or studies of future needs for highly qualified engineers (of which ACAP has

knowledge) would not appear to be contrary to the recommendations to reduce Ph.D. numbers. ACAP has noticed two aspects of the graduate enrolment picture which have not been fully worked out in "Ring of Iron". One of these is the rate of phasing into the recommended levels of Ph.D. enrolment; the other is that the report does not deal very fully with the future distribution of graduate effort amongst the different sub-divisions of engineering. Both of these points are dealt with more fully below, but, in brief, insufficient attention to the first could lead to a most undesirable oscillation from year to year in intake into graduate programmes and in numbers of Ph.D. graduates, while lack of inter-univeristy coordination in responsibility for sub-divisions of engineering might lead to an allocation of graduate students amongst programmes in a way that would lead to undesirable lacunae in the province's graduate offerings.

Assuming then that "Ring of Iron" represents the results of a careful and sufficiently comprehensive study, ACAP advises OCGS and COU to accept the recommendations of Chapter 9 and 11 regarding graduate enrolment, subject to the further examination recommended below in connection with rate of Ph.D. enrolment reduction and with disciplinary enrolment.

The Lapp report recommends a Ph.D. enrolment of 450 in 1973-74. Starting from the current enrolment this could be achieved only by enforcing an un-acceptably low number of new admissions in 1972-73 and 1973-74 followed by undesirably high admissions in 1974-75. This is due to the "pipe-line" effect, i.e. that currently enrolled students will not be graduated until 1974. This is illustrated in Table I and in the figures. These show a model (model A) which achieves the 450 enrolment in 1973-74 and possesses the undesirable fluctuations, and also a model (model B) which reaches the lower enrolment more slowly. Model B represents total of 1573 Ph.D. graduates (and drop-outs) in the decade and an average of 139 per year for the period 1975-80. Since

the Lapp report recommends 125 graduates (excluding drop-outs) per year, model B would seem much more satisfactory without arbitrary and drastic curtailment of enrolment opportunities for students wishing to begin doctoral work in the next three years. These models are based on reasonable assumptions concerning rate of graduation, but, of course, each university could make more reliable estimates of its own, based almost on student-by-student expectations of those currently enrolled.

It seems necessary then to develop an enrolment model for each university and also to determine the consequential disciplinary distribution. ACAP therefore recommends the following procedure:

a. COU request each university to indicate to ACAP how it would break down the graduate enrolment (master's and doctoral) allotted to it amongst its graduate departments or programmes, indicating also the specialities in which graduate work and doctoral research facilities will be offered (using perhaps the headings of Table 5.3 of "Ring of Iron"). It should show also one or two models similar to Table 1 for the enrolment in each department (or programme) and in the faculty. The model used as a first approximation for Ph.D. enrolment should be the one used by ACAP to generate model B, but it is expected that the university will also submit any variant plan which seems academically desirable.

b. On receipt of this information, ACAP collate it and discuss it with each of the engineering discipline groups and with CODE to determine if the distribution of effort amongst fields of engineering seems appropriate.

c. If changes in the pattern so generated seem desirable, they should be formulated for ACAP by the discipline groups and reported to the

universities as suggested revisions to their plans.

d. After receiving university reactions and CODE reaction to these suggestions, ACAP will report to COU on the recommended distribution amongst the universities of responsibility for various fields of specialization and on recommended Ph.D. enrolments by university by year.

Initially, the principal concern would be with enrolments up to 1975, although developments up to 1980 would need to be foreseen in outline. The work suggested would need to be done in a short time (say by January) and after this the discipline groups and CODE could turn their attentions to other matters such as the study of possible new forms of graduate work in engineering and more detailed projections of the last half of the decade.

The procedure recommended above is thought to offer the opportunity to accept the graduate recommendations of the report, examine their detailed consequences and introduce any refinements such a study suggests. To use an engineering simile, the Lapp report is accepted as the first approximation and a second approximation is generated modifying the first to a small degree.

Recommendation (10:1) suggests that it is essential that changes in the B.I.U. formula be considered concomitantly with the development of the system. ACAP agrees that a change in methods of providing funds for research work is desirable and necessary. It does so without evaluating the issues surrounding the accuracy of the cost analysis in the report, but on the basis of its conviction that this is a principle of general application to its planning assessments. It is recognized that research is an activity distinct from graduate study, and that the quality of a department does depend on the opportunities available to its members to engage in research. At present a good deal of funding for research comes in a form related to graduate

activity. Hence, if provincial planning dictates that graduate work not be conducted in a given department, it is necessary that faculty research in that department be funded in a manner distinct from that in departments with full graduate programmes. ACAP believes that urgent consideration should be given to mechanisms for dealing with this problem. It so recommends to OCGS and COU.

Recommendation (5:1) suggests that the criteria of acceptability of graduate degrees in engineering should be recast in order that a thesis based on design or systems synthesis may be suitably assessed. This could involve the establishment of a new degree at the doctorate level. ACAP recommends that OCGS and COU concur and express the hope that Engineering Faculties and CODE will take some initiatives to promote the examination of new forms of graduate degree programmes both at doctoral and master's level.

Recommendation (4:2) suggests a report for Ontario like the Cartter report on relative quality of graduate departments in the USA. ACAP feels that the aims towards which this recommendation is directed will be much more satisfactorily met by the succession of planning assessments now intended. It therefore recommends that this recommendation not be adopted.

Recommendation (4:1) suggests a talk-back television network in Ottawa. In so far as this is a technique for part-time master's degree instruction, ACAP recommends that Carleton and Ottawa examine its cost-effectiveness in relation to alternative methods. It is understood that there is already full interchange of credits towards master's degrees at Ottawa and Carleton and it is recommended that these universities continue to arrange their course offerings to prevent undesirable duplication in any given year.

Concluding Note

ACAP would like to make it clear to COU and the universities that it has had to deal with the Lapp report in a manner rather different from that which it hopes to follow in the other planning assessments. For one thing, ACAP consultants, carrying out a study of lesser scope than that assigned to the Lapp committee, would have more detailed terms of reference at the graduate level and would be expected to make more detailed recommendations down to the level of sub-disciplines -- the activity the universities and discipline groups are now being asked to undertake. Secondly, discipline groups, universities and relevant COU affiliates will have an opportunity to react to consultants' reports before they are published, and the report, the reactions, and ACAP recommendations will appear in public simultaneously.

September 1, 1971.

Table 1: Models of Engineering Ph.D. Enrolment (Full-time)

In each year, G is the number of graduates and drop-outs from previous year's enrolment
C is the number of students continuing from previous year's enrolment
N is the number of new students beginning Ph.D. work
T is the total enrolment.

Model A assumes (a) the 1971-72 enrolment to be the most recent forecast (usually June 1971);

(b) the Lapp report enrolment for 1973-74 is achieved and remains constant through 1976-77.

Model B assumes (a) the 1971-72 enrolment to be the most recent forecast;

(b) the Lapp report enrolment for 1973-74 is achieved in 1974-75 and then increases slowly as a constant fraction of the total graduate enrolment recommended in the report.

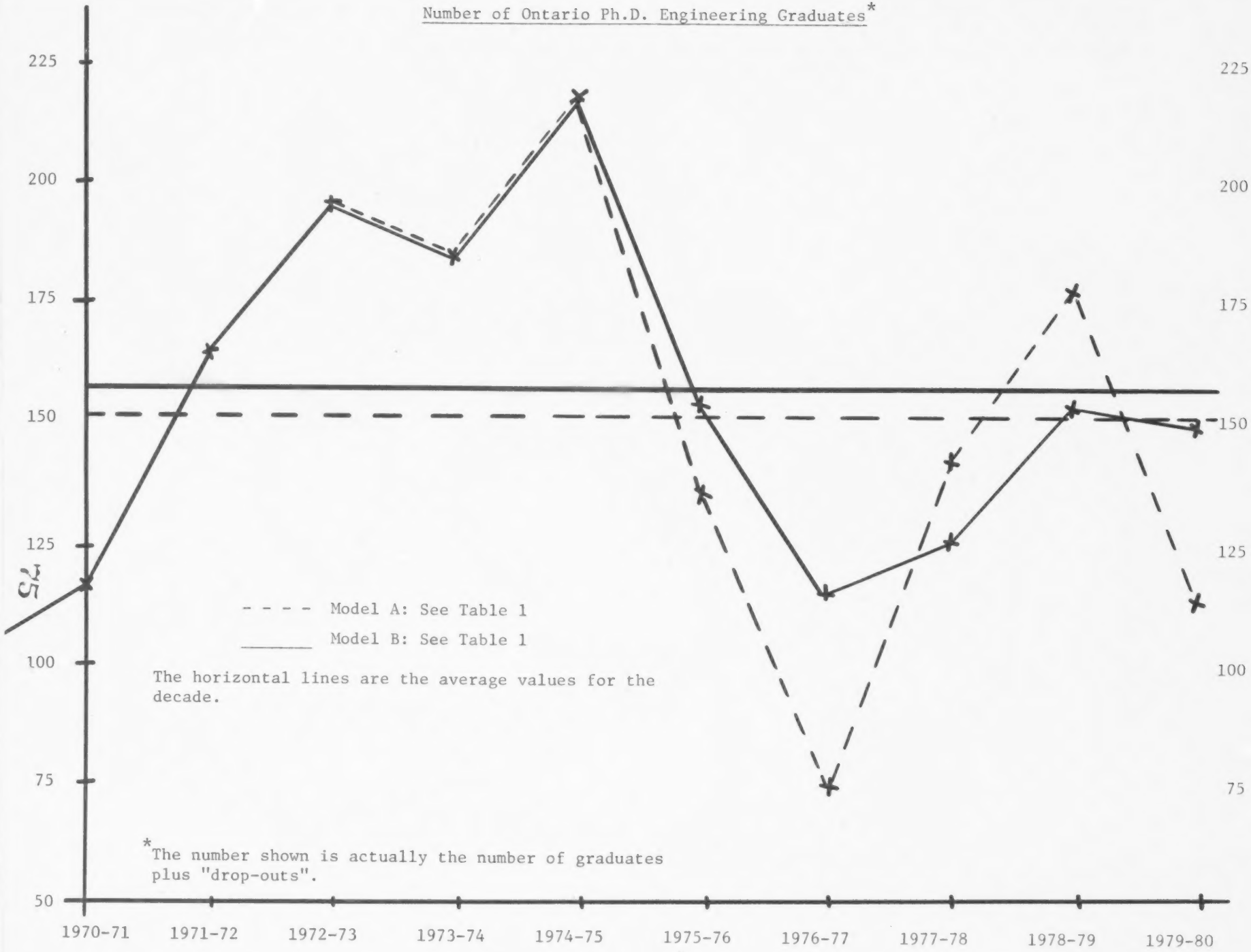
Model A' and Model B' show the effects of assuming that the 1971-72 enrolment is equal to the 1970-71 enrolment.

Notes: It is assumed that the Carleton-Ottawa enrolment will drop for some years because of the shift to a new Ph.D. programme in communications and that Ph.D. work at Western in environmental engineering also will take some time to be established.

These figures are models only and can be refined by more precise knowledge each university has of the rate of graduation of its current students. It has been assumed that the average time as a Ph.D. student is 3.5 years.

	1970-71	1971-72				1972-73				1973-74				1974-75				1975-76				1976-77				1977-78	1978-79	1979-80
	T	G	C	N	T	G	C	N	T	G	C	N	T	G	C	N	T	G	C	N	T	G	C	N	T	G	G	G
Toronto A	241	55	186	65	251	72	179	29	208	72	136	29	165	72	94	71	165	50	114	51	165	29	136	29	165	50	62	40
A'	241	55	186	55	241	72	169	34	203	72	131	34	165	72	93	72	165	42	123	42	165	34	131	34	165	57	45	38
B	241	55	186	65	251	72	179	45	224	72	152	43	195	72	123	42	165	57	107	60	167	45	123	47	170	44	52	53
B'	241	55	186	55	241	72	169	48	217	72	145	46	191	72	119	46	165	51	114	53	167	47	120	50	170	47	49	52
Queen's A	56	12	44	25	69	17	52	9	61	15	46	9	55	25	30	25	55	17	38	17	55	9	46	9	55	17	21	13
A'	56	12	44	12	56	17	39	15	54	15	39	16	55	19	36	19	55	13	42	13	55	16	39	16	55	18	15	15
B	56	12	44	25	69	17	52	14	66	15	51	14	65	25	40	15	55	19	36	20	56	14	42	16	58	15	19	17
B'	56	12	44	12	56	17	42	15	57	15	42	16	58	19	39	16	55	13	42	14	56	16	40	18	58	13	19	18
Waterloo A	182	47	135	57	192	52	140	17	157	49	108	17	125	62	63	62	125	38	87	38	125	17	108	17	125	40	52	26
A'	182	47	135	47	182	52	130	22	152	49	103	22	125	59	66	59	125	34	91	34	125	22	103	22	125	42	46	27
B	182	47	135	57	192	52	140	32	172	49	123	32	155	62	93	32	125	45	80	47	127	32	95	34	129	32	43	39
B'	182	47	135	47	182	52	130	35	165	49	116	33	149	59	90	35	125	40	85	42	127	35	92	37	129	33	40	39
McMaster A	53	13	40	22	62	15	47	6	53	14	39	6	45	22	23	22	45	14	31	14	45	6	39	6	45	15	18	9
A'	53	13	40	13	53	15	38	11	49	14	35	10	45	18	27	18	45	12	33	12	45	11	34	11	45	14	15	11
B	53	13	40	22	62	15	47	11	58	14	44	11	55	22	33	12	45	17	28	18	46	11	35	14	49	12	15	16
B'	53	13	40	13	53	15	38	13	51	14	37	13	50	18	32	13	45	13	32	14	46	13	33	16	49	13	14	15
Carleton-Ottawa																												
A & A'	58	15	43	14	57	16	41	7	48	15	33	17	50	19	31	17	48	11	37	17	54	12	42	18	60	17	18	18
B & B'	58	15	43	14	57	16	41	7	48	15	33	17	50	19	31	20	51	11	40	18	58	12	46	18	64	19	19	18
Western	32	9	23	7	30	9	21	0	21	8	13	0	13	9	4	5	9	4	5	6	11	0	11	6	17	3	6	6
Windsor	47	14	33	2	35	13	22	0	22	11	11	0	11	10	1	0	1	1	0	0	0	0	0	0	0	0	0	0
Guelph	2	0	2	0	2	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL A	671	165	506	192	698	195	503	68	571	185	386	78	464	219	246	202	448	135	312	143	455	73	382	85	467	142	177	112
A'	671	165	506	165	671	195	486	89	550	185	365	99	464	206	258	190	448	117	331	124	455	95	360	107	467	151	145	115
B	671	165	506	192	698	195	503	109	612	185	427	117	544	219	325	126	451	154	296	169	465	114	351	135	486	125	154	149
B'	671	165	506	165	671	195	464	118	582	185	397	125	522	206	316	135	451	133	318	147	465	123	341	145	486	128	147	148

TABLE 1: MODELS OF ENGINEERING PH.D ENROLMENT (FULL-TIME)

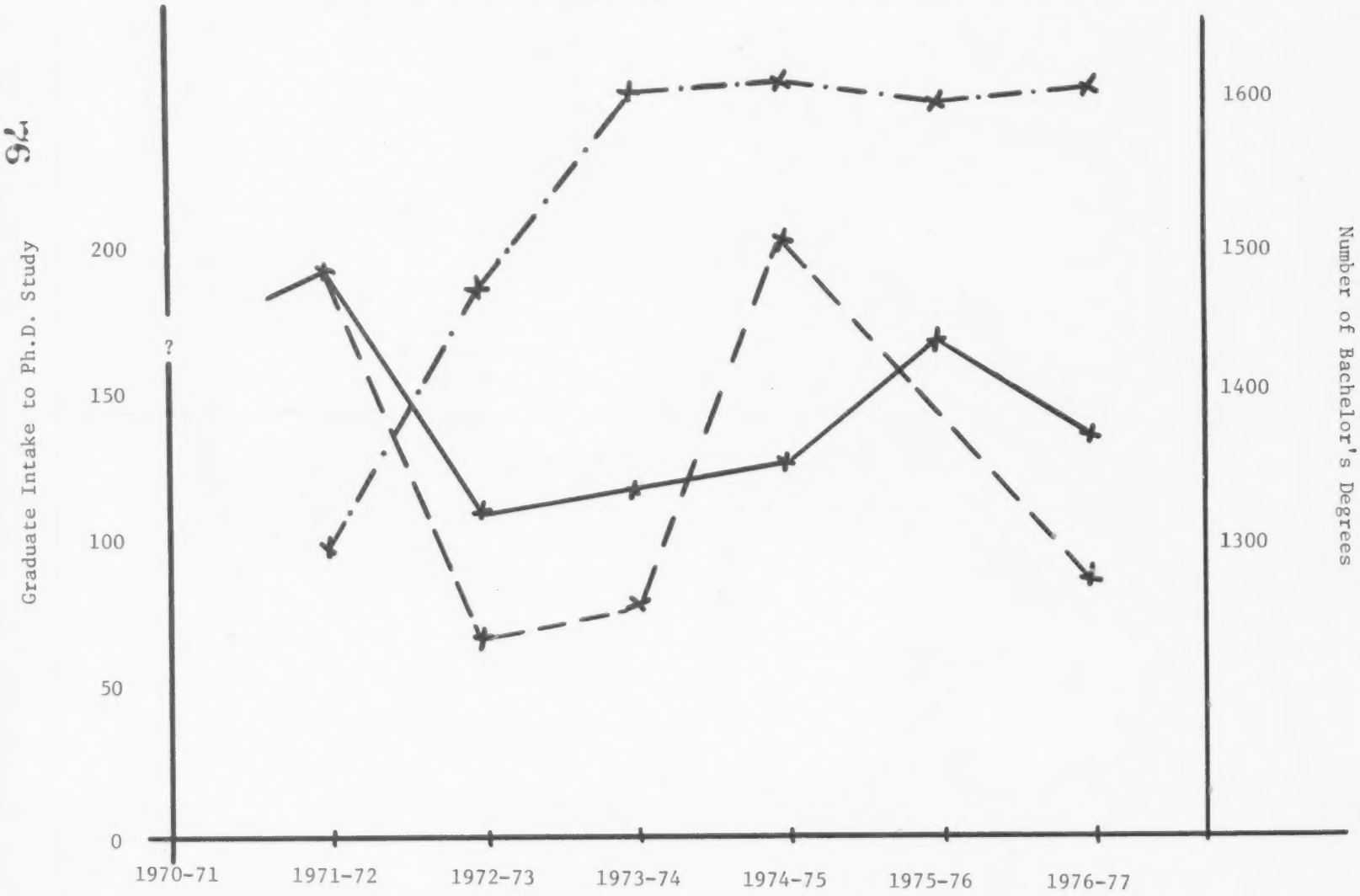

Number of Ontario Ph.D. Engineering Graduates*
225
200
175
150
125
100
75
50
- - - - Model A: See Table 1
_____ Model B: See Table 1
The horizontal lines are the average values for the decade.
*The number shown is actually the number of graduates plus "drop-outs".
1970-71
1971-72
1972-73
1973-74
1974-75
1975-76
1976-77
1977-78
1978-79
1979-80

Annual Intake of New Engineering Ph.D. Students in Ontario

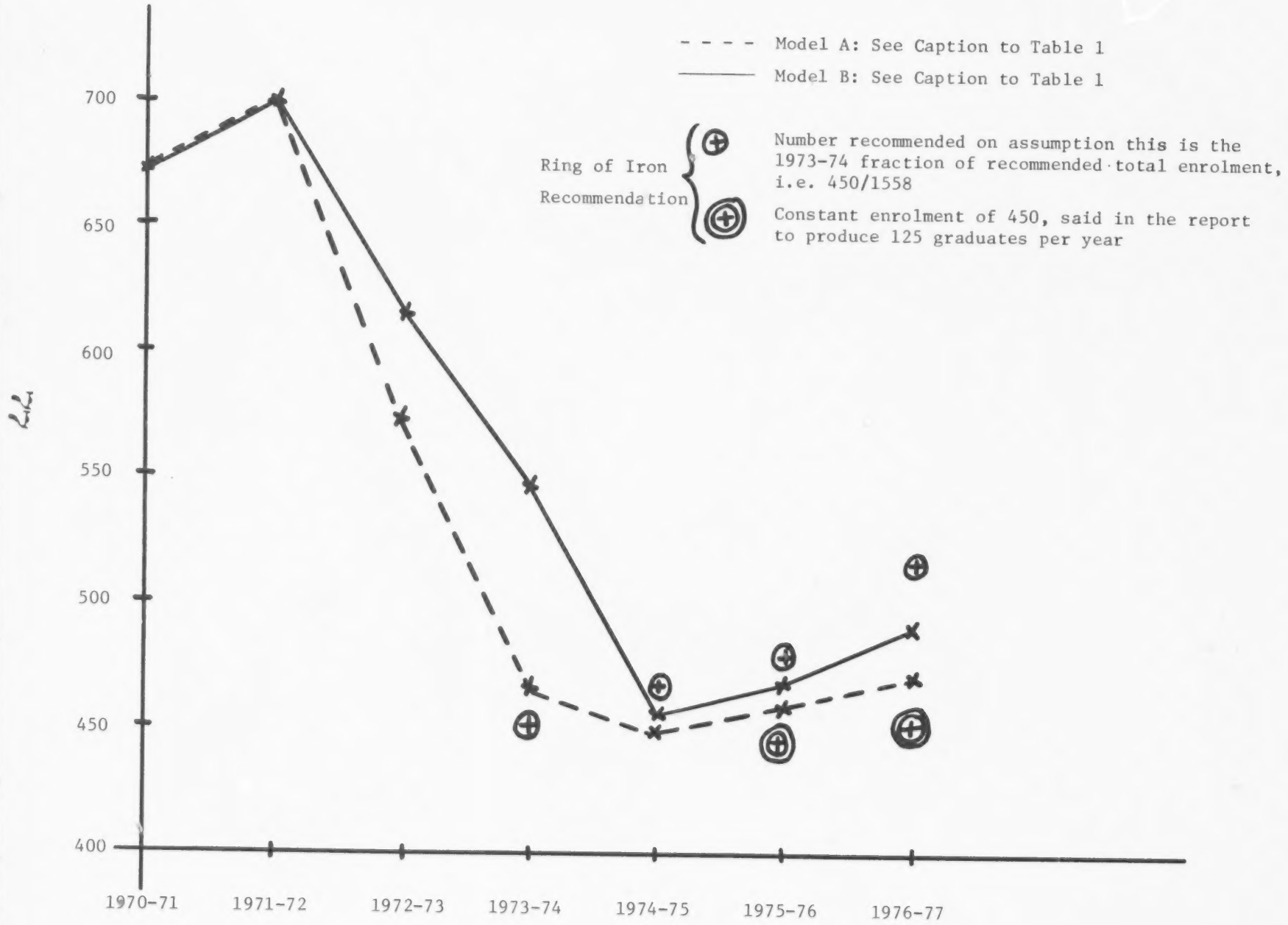
- - - - Model A: See Caption to Table 1

——— Model B: See Caption to Table 1

- · - · Average of the number of Engineering bachelor's degrees awarded in Ontario two and three years previously -- from "Ring of Iron" Table 9-10.



Ontario Total Full Time Engineering Ph.D. Enrolment



THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO

Professional Engineers Bldg.
236 Avenue Road
Toronto 5, Ontario
Telephone 416-924-5726

The Council of Ontario Universities,
102 Bloor Street West,
Toronto 181, Ontario.

RE: "RING OF IRON"

Gentlemen:

The Association of Professional Engineers of Ontario, both indirectly through its identification with the Ontario Engineering Advisory Council and directly with the Task Force, has maintained a substantial and continuing interest in the study of the future of engineering education in Ontario as commissioned by the forerunner of the Council, and as now recorded formally in the "Ring of Iron". The Association was pleased to have the opportunity to provide certain input to the study while it was proceeding. Its Council has since read and studied the 'Ring of Iron' and wishes, at this time, to record the fact that it welcomes the report of the Task Force on Engineering Education in Ontario as a comprehensive, objective, illuminating overview of this complicated segment of the Province's university system. The Council has determined to respond to the Report directly to the Council of Ontario Universities, which it does so, briefly and in summary below. At the same time, it wishes to assure the Council of Ontario Universities of its desire, in the public interest and in co-operation with educational organizations, to offer any assistance within the reasonable resources of the Association, in the practical implementation of those portions of the Report in which it might become involved.

It is to be remarked at the outset that the Association intends that its principal response be directed towards Chapter 7 of the report–"The Profession", in which area the Association believes itself able to comment with suitable competence. The Association records here its attraction to the definition of engineering which formed the basis of "Ring of Iron", i.e. "engineering is a profession, responsible and accountable for man's physical environment, its management, and control", despite its normal preoccupation with the more practical legal definition with which it must deal daily. Certainly the philosophy so expressed–and accepted–permits consideration of the specific recommendations made in a suitable perspective.

There is an unmistakable challenge for the profession in the conclusions of the report–a challenge to accept a joint responsibility with the engineering educational system to work towards merging relationships, responsibilities, and identification not only in the practical implementation of the suggestions and recommendations of the report, but in the effective fulfilment of the profession's obligations to society. The Association has taken up this challenge.

Particular comment is made below on the main topics dealt with in Chapter 7–"The Profession", and the specific recommendations made in each one of those sections. Brief reference is also made to certain of the conclusions of Chapters 9 and 11.

ENTRANCE INTO THE PROFESSION

The commentary provided by the report, as a preamble to the principal recommendation, is factual and needs no further elaboration. A more specific comment is to be made, however, in respect of the main recommendation, which is reproduced here for the purposes of comparison with the remarks which will follow:

Recommendation 7:1–"It is recommended that the universities introduce part-time undergraduate studies as an acceptable alternative path to a recognized bachelor's degree in engineering, and that when this scheme is fully operative, the present APEO examination system be terminated."

The Association has already taken action which has, essentially, the same objective as recommendation 7:1. For a number of years, various Committees have been considering the suitability of continuing the Association's examination program in the same form, if not the same extent, which applied some 50 years ago. These studies resulted in the presentation of a resolution in September 1970, later confirmed fully by the Council of the Association in January 1971, to the effect that "an engineering degree should be adopted as an essential requirement for admission to the pre-registration examination program, with the understanding that confirmatory examinations would be required of all applicants presenting degrees from engineering courses not recognized or accredited; that the foregoing be considered to be the final objective of an orderly and planned program of evolution of seven years' duration; and that in parallel with the foregoing, the Association actively pursue a program to encourage universities to provide proper and adequate credits to graduates of technical institutes, together with proper and adequate connecting or transition courses, both to permit and to facilitate the technologist in obtaining a recognized engineering degree with a minimum of formality and time."

Subsequently, a practical program of implementation of the foregoing resolution was adopted by Council and has been promulgated to educational institutions, licensing and technical bodies, and other interested parties. A copy of the program is attached to this memorandum. Additionally, the Admission Standards Committee of the Association has been formally charged with the responsibility for working actively in co-operation with the Committee of Ontario Deans of Engineering and with representatives of the Colleges of Applied Arts and Technology and of Ryerson Polytechnical Institute to encourage and to hasten the development of ways and means by which the essence of recommendation 7:1 itself can be accomplished.

While it is the hope and expectation of the Association that the objectives of the program will be realized within the proposed time limits, there is always the possibility that they may not–and that a re-assessment of the whole matter will be required. It is noted additionally that there remains a substantial concern on the part of such resource industries as mining, and pulp and paper, in remote locations, that with implementation of the Lapp Report recommendations sufficient opportunities for formal training of any kind will not be available locally, and that, as a consequence, an alternate self-study route to registration must remain open with the profession administering such tests as it deems necessary. The Association recognizes this particular 'problem', but feels that the only appropriate position it can take is that acknowledgment of failure, even in one small area, will not be made until all reasonable efforts have been put forward and the period allowed for development of alternate means has been exhausted.

In respect of entrance standards, this Association, in common with other licensing bodies, has long considered,

and will continue to consider, the necessity and desirability of raising both academic and experience requirements for first registration. Specifically, the possibility of making a higher degree and longer experience compulsory has been entertained. Similarly, and in keeping with the acknowledged need for the 'broadening' of the engineer for greater emphasis on social responsibility, an 'expanded' baccalaureate degree of five years duration has been considered.

Decisions in these areas have not been made, as certain obvious conflicts with the concept of universal registation arise. Reduction of such conflicts appears to require a change to the concept of 'selective' registration–a major move not yet suitably evaluated by the Association.

The proposal for the establishment of some form of pre-registration 'test' to be undertaken by all applicants, subsequent to the completion of suitable engineering experience and prior to registration, has received, periodically, similar attention by various Committees of the Association. It continues to be a matter of discussion, but one of less urgency than certain other matters, and one which will undoubtedly be strongly influenced by the future methods of 'testing' adopted by the universities, and by numerous other factors impinging on the profession itself. The authors of the report express some concern that, in the processes proposed, the universities may gain what amounts to monopolistic control of entry into the profession itself. Such a concern, considered in the environment observed by the writers of the report, might well be justified. However, when viewed in the context of 'the profession and the educational system, indivisible' as indeed recommended by the report, such concerns must be substantially reduced.

REQUALIFICATION

Recommendation 7:2–"periodic requalification (perhaps every five years) be initiated so as to require successful completion of a course of study in either control or management, or a combination of these two, together with a structured program in applied humanities."

The authors of the report suggest here a procedure which would be intended to go beyond the present system, which, in effect, certifies as to the qualifications which an individual possessed at the time of his registration, and moves towards the certification of competence at periodic intervals.

In this instance too, it can be stated that the principle referred to above has been before the Association and many of its Committees for some considerable time. In its consideration of any move towards 'requalification' for the purpose of providing increased protection of the public interest, the Association has found itself confronted with a number of factors, all of which mitigate against the rapid and the universal application of such procedures. As an example, current membership of 30,000 would appear to present a demand for educational service and assistance, and for examination, well beyond the total capabilities of all of the engineering institutions in the Province, and of the Association itself in respect of any or all of its facilities and abilities. Or, put another way, as the Association sees it now, *compulsory universal requalification* is well beyond the financial, the physical and the academic capabilities of the education-profession 'system', both as it is now, and as it can be envisaged in the future. Practically, too, the Association has no legal ability to cancel or to suspend membership based on failure to pass requalification 'tests'. The Association recognizes that other evolutionary possibilities exist, such as the arbitrary adoption of 'D-Day', some date in the future beyond which all new registrants would be required to

re-qualify on a regular basis. Even this alternative would require an educational effort equivalent to a significant proportion of all engineering undergraduate instruction and which would prove an excessive burden on the individuals involved and on society, unless more effective teaching and learning processes become available.

If directed to practising engineers only, encouragement through subsidization of continuing education programs for such engineers, presented by universities, might well represent a practical alternative which would approach the suggestion of the report. Current thinking favours concentration on a gradual movement towards voluntary certification of 'specialists' as a means of determining 'competence'.

Thus, it is the Association's present feeling that it is possible to evolve toward the ultimate objective by a process of 'voluntary super-registration', or, in effect, creating additional levels or categories of registration for specialists of various kinds, who may achieve such super-registration, if they have the wish and the will to do so, by the satisfying of special education and experience requirements beyond those designated for compulsory registration as a professional engineer. For this limited group of individuals, the process of super-registration would, in effect, be a peer assessment of competence, which would require to be repeated periodically, probably at the five year period suggested by the report.

If the educational institutions are to be a part of the requalification process for practising engineers, then the question arises as to who should undertake the requalification of engineering teachers. Connected with this of course, is the principal question of what requalification is intended to do. To the latter query, it would appear to be fair to say that the fundamental purpose of such requalification is not just to bring an individual up to his original degree competence, but to bring him up to a current standard related to his actual work. If such be the case, then it would seem desirable as suggested by Dr. J.W. Hodgins, that the requalification of engineering teachers should include a demonstration of 'outside' involvement, and the elements of a requalification program might well include:–

(a) The design of successful industrial apparatus.
(b) Consulting engineering reports.
(c) Entrepreneurial enterprise.
(d) Industrial sabbatical activity.
(e) Patents.
(f) Professional and technical society participation and activity.

Briefly, a more realistic involvement of the engineering-teacher in the profession should prove significantly beneficial to the undergraduate engineer, to the teacher, and to the practising engineer. The tests to be applied, the criteria of acceptability, and the conducting of the process itself should remain with the university.

ACCREDITATION

For some years the Association of Professional Engineers of Ontario has undertaken a process which it has termed 'accreditation' and which has dealt with new engineering programs in developing universities. Its objectives have been to assist the university in its formative period, and to assure the Council of the Association that the program in all of its aspects will meet the requirements of the Association, and that its graduates will be qualified to be admitted to membership without further examination.

In the preamble to recommendation 7:3, the authors of the report make reference to three different terms 'accreditation', 'appraisal', and 'assessment'. It would appear that these three terms represent three processes with different objectives and different procedures. From the standpoint of the profession, 'accreditation' is a process designed purely and simply to establish acceptability of an engineering program for registration purposes. While there are obviously qualitative and quantitative elements to this process, its object is extra-educational. It is not intended to be a criterion for funding, for example. There are equally important but separate and distinct intra-education processes which must be considered. By the Council's own definitions, 'appraisal' procedures would be expected to be those designed to expose the quality of undergraduate programs, the degree of educational excellence and effectiveness of individual programs at individual universities. On the other hand, 'assessment' procedures would be expected to be procedures which would deal with 'needs' and 'demands', and would relate to all like programs given at all participating institutions. The latter process would be concerned with duplication, with cost, and with manpower. It could be expected that 'appraisals' and 'assessments' might well develop, in effect, into criteria for funding.

On the basis of the foregoing, the Association would agree with the logic of recommendation 7:3, which reads "that CODE undertake the appraisal of proposed new undergraduate programs, using essentially the same procedures employed by OCGS in regard to new graduate programs. Also, CODE should evaluate the need for each new program with respect to academic, cost and manpower considerations. In regard to such appraisal, CAB should participate so as to avoid unnecessary duplication and permit simultaneous accredition." As the instrument of intra-educational procedures, CODE or a designee thereof would indeed appear to be a proper agency. Development of suitable procedures should certainly take place with full knowledge of those now in effect and used by the Canadian Accreditation Board for the purpose of 'accreditation', so that any one of these processes can, to the maximum extent, supplement the others and reduce total effort. In all of this, it must be made clear that the profession has no feeling that it is in any way abrogating its responsibilities nor that it has any wish or desire to do so.

It should be pointed out that the Association of Professional Engineers of Ontario has already taken a step presaged by the authors of the report - it has disbanded its own Accreditation Committee and has transferred the responsibility for the accreditation of Ontario engineering programs for registration purposes to the Canadian Accreditation Board, the principal Committee of the Canadian Council of Professional Engineers.

The Canadian Accreditation Board has already embarked on a three-year program to 'reaccredit' existing courses for registration purposes. Procedures have been established, and have been promulgated to educational institutions with request for comment and suggestions. The procedures are now essentially stable, and the Canadian Accreditation Board is beginning to respond to requests from universities across Canada giving degrees in engineering. Procedures and techniques, at this early stage in the development of the program, do not involve the relatively sophisticated procedures suggested by the authors of the report. However, as additional data become available, it is expected that these procedures will evolve towards more efficient, effective, and accurate modes.

Recommendation 7:5—"that all engineers engaged in teaching in Ontario be registered members of the profession." This recommendation is one of substantial interest to the Association and one to which the unqualified support of the profession is extended. However, in extending this support, the Association must record the very wide di-

vergence of opinion amongst academics as to the necessity and the desirability of such a move and must acknowledge some complications which arise as a result of components of or deficiencies in professional engineering legislation and in provincial labour legislation. Members of the Association who are teaching engineering-type courses at university or community college level are affronted when informed that such teaching is not included in the legal definition of the practice of professional engineering and that there is, therefore, no legal compulsion on such a teacher to be registered – unless he anticipates offering professional engineering services, as legally defined, and as a part-time consultant in parallel with his teaching activity. It would appear that the remaining 'qualified' individuals engaged in teaching at these two levels feel equally strongly that there should be no compulsion on them to join a professional association that has to do with the practice of engineering – something which is not within their terms of reference or sphere of interest.

Attempts have been made in Canada to bring university teaching of engineering courses under the professional regulatory act. These attempts have failed due to the effective 'lobbies' made against such legislation by academics opposing the idea. It will be the intention of this Association to encourage to the full extent of its ability the registration of all persons teaching engineering at university level, and it is encouraging to report that, in some institutions, considerable initiative has been taken by the members of the staff themselves. Additionally, it is expected that some attempt will be made to assess the post-Lapp report feelings of faculty members with respect to voluntary registration, and also with respect to possible changes in the legal definition referred to earlier.

The preliminary 'feeling' of the Association is that it would be desirable to include within this legal definition of practice those engineers who are teaching engineering subjects. Such general wording however may give rise to considerable debate as to which persons would then be compelled to be registered. This debate could, no doubt, be lessened somewhat by the adoption of the wording of the Model Law of the National Council of Engineering Examiners of the USA – "The practice of engineering shall mean any service or creative work, the adequate performance of which requires engineering education, training and experience in the application of special knowledge of the mathematical, physical and engineering sciences to such services or creative work as . . . . .engineering teaching of advanced engineering subjects or courses related thereto. . . . .".

It will also be the intention of the Association to encourage and to support any programs which will help to bring into closer appreciation and understanding the teaching engineer and the practising engineer. Mechanisms for employment interchanges between universities, industry, and indeed government should be developed by and thru the co-operation of representatives of each of these. Increased opportunities for consulting while teaching, for industrial sabbatical leaves, for the use of adjunct professors, for the use of sessional lecturers from industry would be applauded by the Association. However, at the same time the Association recognizes that the practising individuals' theoretical horizons tend to contract progressively with each year away from school and, except in the case of the most extraordinary practitioners, such persons may not be able to become fully integrated and effective teachers without undertaking appreciable academic remedial work. However, where the essence of the courses to be taught is more closely related to practical, technical, industrial, or business applications, as opposed to instruction in theoretical subjects, practising engineers would appear to have real potential as effective teachers.

The foregoing comments refer to that section of the report which emphasizes the 'oneness' of the profession and of the educational system – Chapter 7. While there are many other areas of the report which arouse interest

and which encourage 'opinion', it has been the decision of the Council of the Association to restrict its comments to those areas which involve its acknowledged responsibilities or which can have a direct effect on it. There are two brief comments to be made on matters outside, but related to Chapter 7, however.

RYERSON POLYTECHNICAL INSTITUTE

The first of these deals with the new authority granted to Ryerson Polytechnical Institute to provide a degree program for diploma technology graduates. This Association has long recognized the unique and important position of the technology graduate, and has repeatedly suggested that means must be provided to the technologist to enable him to enlarge his career interests, his capabilities, and his opportunities – by the provision of continuing education courses and advanced technology courses, perhaps leading to a Bachelor of Technology degree, and by the ability to move much more freely into professional courses at university level. These comments have been made previously to the Commission on Post-Secondary Education in Ontario, and are contained in a copy of the brief thereto, which is attached to this communication.

While the Association has supported the development of such opportunities for the diploma technologist, it has received only the most sketchy information concerning the probable nature of the degree course being considered by Ryerson Polytechnical Institute. The Association's concern in this matter stems from the uncertainty as to the real objectives of this course. Is it to provide the 'next step' opportunity for the technologist, or is it intended to be a final step to registration and practise as a professional engineer? Such a possibility would rest entirely on the nature and extent of the proposed course as compared to the current entrance requirements of the Association which are set at the baccalaureate engineering degree level. Clarification of these matters for the students entering the proposed courses, and for the profession itself, is essential. Indeed the Association had felt that the implementation of such a degree might have been deferred until full consideration has been given to the two major and related studies, the "Ring of Iron" and the report of the Commission on Post-Secondary Education in Ontario. However, the program is now understood to be in process, and, it is presumed, will be made available for review at an appropriate time by the Canadian Accreditation Board in such detail as will establish its relationship to current registration requirements.

Pending such determination, the Association would echo the concern of others that the fact of the new Ryerson degree might lead to proliferation of engineering degree granting institutions or courses in contradiction to the findings of the Ring of Iron and to the possible detriment of the relatively newly established and successful programs for the training of engineering technicians and technologists.

CANADIAN ENGINEERING MANPOWER COMMISSION

Recommendation 9:2–"That the Canadian Council of Professional Engineers explore ways and means of establishing a permanent Canadian Engineering Manpower Commission in order to provide national and regional data on engineering manpower in Canada," is one which this Association has supported in the past, and will continue to support in the future. The Canadian Council of Professional Engineers had undertaken a feasibility study in an effort to develop an organizational mechanism and sufficient interest for funding, in order that such a Manpower Commission might be established under the aegis of the engineering profession in Canada and with the active involvement of the appropriate federal government agencies. Dr. Lapp's findings to date have confirmed that the principal interest in the data which derive from such a program lies with educational institutions, and to a lesser

extent with professional associations. Indications of interest and support from other segments, such as government and industry, have been insufficient to provide any sort of guarantee. Thus it appears that, if such an instrument is to be created, it will require to be funded initially by the educational community. The profession, therefore, adds its encouragement to the Council of Ontario Universities, and to the Provincial Government to take an active and supporting role in the ultimate establishment of a Canadian Manpower Commission. It will be the additional intention of both the Association of Professional Engineers of Ontario and of the Canadian Council of Professional Engineers to endeavour to enlarge the current interest of the Federal Government in this undertaking to the point of real support, both in financial matters and in the provision of specialized services and facilities.

The Association appreciates both the importance of 'demand' projections for educational planning, and the difficulties attendant on making such projections. It is this latter concern which leads to its enthusiasm for the establishment of adequate sources of such data. It is the same concern which causes it to comment on the forecasts of 'demand' made by Dr. Lapp in Chapter 9 - and which are acknowledged by him as arising primarily from projections of 'supply' of students available to the unversity system. It suggests that there is far from sufficient information as to the 'needs' of employers of engineers, and the 'demand' for graduates which would arise therefrom, for this Association to agree with the optimism of Dr. Lapp. While acknowledging that the versatility and ubiquity of the engineering graduate will lead him ultimately to useful employment in society, the proportion who are 'needed' for practice as engineers would appear to be less than the prognostications made by Dr. Lapp.

This commentary is concluded with the commendation of the profession to the Council of Ontario Universities for its foresight in commissioning the study of engineering education in Ontario, which study has already become an international reference. Similar commendations must go to the authors of the report who have provided a masterful overview of engineering education in the Province, who have offered many possible avenues for change, and who have not neglected in that process to allow for practical alternatives.

The Association of Professional Engineers
of the Province of Ontario

W.K. Bilanski

W.K. Bilanski, P.Eng., President

9:71

THE ASSOCIATION OF PROFESSIONAL ENGINEERS
OF THE PROVINCE OF ONTARIO

BRIEF TO THE COMMISSION ON
POST-SECONDARY EDUCATION IN ONTARIO

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OF THE PROVINCE OF ONTARIO

BRIEF TO THE COMMISSION ON POST-SECONDARY EDUCATION IN ONTARIO

SUMMARY

The Association of Professional Engineers of the Province of Ontario wishes to place before the Commission comments on some facets of post-secondary education in the Province, and to suggest certain remedies, palliatives or investigations which might lead to benefits to all citizens of this province.

As might be expected, the comments made hereafter deal primarily with engineering education, but attempt to avoid direct competition with the CPUO Study on Engineering Education in Ontario. There is some comment on educational processes and practices, on the profession and education, on facilities, and on methods for improvement of efficiency and effectiveness. The principal suggestions have been recorded, very briefly, below:

- Universities and Colleges should become the principal facilities for continuing education
- Certain Colleges of Applied Arts and Technology should be designated as centres for advanced and continuing education for technologists
- Educational processes should be restructured to become 'continuous' and flexible, permitting 'earning while learning'

  Major research programs should be directed toward the development of specialized selection procedures which will identify the interests and capabilities of applicants to Universities and Colleges
- Centralized careers information systems should be available to all schools and guidance staffs
- Professional experience should be a suitable qualification for engineering teaching; professional practice while teaching should be required
- Suitable 'transition' courses should be made available for technologists so that they may enter engineering degree courses at the highest possible level, and complete the degree requirement in the minimum possible time
- Effective integration of programs given at Universities and Colleges is needed to reduce duplication of courses; and to make Colleges 'feeders' to shortened 'post-diploma' engineering courses
- Major research programs to improve productivity in education should be instituted, postgraduates should be required to write on these subjects, or on pressing problems of social concern
- Criteria for viability and saturation should be established forthwith—to be applied to both new and to existing institutions
- One or more existing institutions should be designated as 'experimental' for the development of courses, processes, methods
- Facility usage should be increased from 'periodic' to 'continuous'
- Efficiency improving techniques and equipment, such as 'performance contracting', 'instructional television', 'centralized information retrieval and storage', 'computer assisted instruction', 'computer managed instruction', should be adopted in maximum possible degree.

Amplification of the foregoing is given in the accompanying 'brief', with the hope that it may prove of assistance to the Commission in its task. Some of the comments may be considered to be outside the terms of reference of the study; nevertheless, they have been presented as representative of areas of concern within the profession.

The Association offers its facilities and resources, within reason, to assist the Commission, subsequently, in the development of any particular and appropriate aspect of its study.

The Association of Professional
Engineers of the Province of Ontario

L.S. Lauchland, P.Eng., President

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO

BRIEF TO THE COMMISSION ON POST-SECONDARY EDUCATION IN ONTARIO

The Association of Professional Engineers of the Province of Ontario is the licensing body for the profession in this province. It administers The Professional Engineers Act, 1968-69 with the following basic objects:

"(a) to regulate the practice of professional engineering and to govern the profession in accordance with this Act, the regulations, and the by-laws;

"(b) to establish and maintain standards of knowledge and skill among its members; and

"(c) to establish and maintain standards of professional ethics among its members."

As a consequence of the foregoing the Association maintains an active interest in all educational processes and opportunities which lead initially to professional qualification, and subsequently to the development and maintenance of greater technical competence, and to enlarged satisfactions in a professional career.

Additionally, many of its 30,000 members are engaged personally in educational activities, ranging over all levels and all institutional types. It is the observation of the Council that widely varying views are held by individual members of the Association, whether in teaching, in industrial employment, government service, or independent practice. However, while recognizing the sincerity of these views, and (often) their irreconcilable nature, the Council of the Association, as a representative body, does wish to put before the Commission certain consensuses which have been reached in its discussions.

THE PROFESSION

As might be expected, the Association's principal interests—and comments in this brief—relate to engineers and to engineering education, and are made with due consideration of the profession, its position in today's society, and of the probable demands of the future. However, the principles involved may well be equally applicable to other fields.

Engineering has been termed the 'second oldest profession' in the world. The exploits of 'engineers' during the period of recorded history have been reasonably well documented; monuments to their achievements are to be found everywhere. The profession has lived on and promoted 'change' up to this time, with the favoured field of engineering changing itself progressively over the years thru military, civil, mechanical, electrical, systems, and scientific emphases as the development of the country appeared to require.

It is, perhaps, ironic that the profession whose trademark has been 'change' now finds itself troubled by a changing world, changing rapidly as a result (in part) of the profession's past successes. Society seems to have turned on its benefactor—and while continuing to use and to demand every technological advance, is soundly criticizing the profession for not having had the omniscience to foresee and forestall the escalating effects of population growth, industrialization, and urbanization.

The ground rules have changed—and the profession must change to keep in step, and to shoulder the new responsibilities which society is demanding be accepted. Professor Allen B. Rosenstein, UCLA Systems Engineering Department, says "The short time between social action and reaction, between technical innovation and mass distribution, precludes the continuation of the traditional patterns of professional responsibility at the local level, and nearly total irresponsibility nationally . . . . .and, consequently, professions must find the means to make a quantum jump in their social responsibilities".

As a consequence of the current situation the profession in Ontario has been attracted recently to the re-definition proposed by Dr. Phillip A. Lapp, P.Eng.,—"Engineering is a profession responsible and accountable for man's physical environment". It is from this point of view that subsequent commentary is made.

It would follow from the foregoing that maintenance of traditional patterns of practice and of education cannot be expected—that new emphasis must be given in sequence, perhaps, to environmental engineering, and then to societal engineering. These are major departures from tradition and foreshadow a change of substantial dimensions in the education of the engineer. It is not suggested that the traditional disciplines will disappear but that environmental, and societal engineers will form a bridge between the traditional disciplines and the requirements of societal systems. Needless to say the 'new breed' will be 'people oriented', rather than 'thing oriented'.

CONTINUING EDUCATION

It would be difficult now to find an informed individual who would deny the need for, or the value of, continuing education in achieving career satisfaction, adequate effectiveness and enlarged competence. Some authorities are convinced that to maintain competence and to provide a suitable growth of ability, a professional of the future must be prepared to spend at least 20% of his time in continuing education, one day in five, after completion of formal schooling.

The principal responsibility for continuing education must

rest with the individual, without whose mature appreciation, interest, desire and determination, related efforts would be ineffective and wasteful. However, given the required motivation on the part of the individual, a responsiblity for encouragement and accommodation in terms of financial and time allowances must rest with the employer, and finally a responsiblity for the establishment and maintenance of minimum facilities and staff must rest with the educational institution. Continuing education activities may be divided into four basic categories of study: remedial-technical, professional development, business development, advanced-technical. While there is room for home-study and for in-house instruction, it is expected that the major facility will be university or college centred and will be arranged for extension, part-time or sandwich courses, or for night instruction—in each case providing some tangible credit or recognition for accomplishment, up to and including granting of degrees earned as determined by examination or test, not by full-time attendance.

It is suggested that:

(a) **Continuing education programs and facilities covering remedial, developmental and advanced fields must become an interest and major part of the day to day responsibilities of all universities giving professional courses;**

(b) **Continuing education programs of a developmental or advanced nature become the responsibility of designated Colleges of Applied Arts and Technology, or Institutes of Technology;**

(c) **Industry—university programs, requirements and operations be coordinated and undertaken cooperatively, employing any appropriate facilities and instructional aids, and financed directly by the benefitting industry and/or individual.**

CONTINUOUS EDUCATION

There appears to be a substantial opinion that the current 5-year 'block' secondary school program is highly wasteful of the time, the effort and the potential of both teacher and pupil—and of the taxpayer's dollar. There are movements towards making secondary school education 'continuous'—unstructured as to time, untested as to output—which would permit the student to accomplish his own desires in his own time, within limits. Such a proposal appears to have merit—and to recognize that today's 'TV' exposed student finds little but frustration and harassment in (at least) the last two years of the program.

Such a change could permit the average student to move thru the school in about 3½ years—a time saving which, apart from student satisfaction, can be translated into significant savings in tax dollars. A continuous, flexible education 'tree', with academic trunk and trades, vocational, technological and professional branches extending thru secondary and post-secondary and continuing phases of education, would permit all members of the work force to adjust their educational level as they desire, as their employment demands, or their capacity permits.

Such a program would permit the combining of learning and earning; the proportion of time spent in academic and work environments could be tapered to provide, not only essential sustenance or self-support, but the satisfaction of accomplishment and continuous feed-back as to the nature of the next phase of a person's educational endeavour. Such a learning-earning situation can apply throughout all types of training, trades through professional, involving some sort of stability, or equilibrium being reached eventually, after which, if desired or required, a relatively fixed proportion of time could be devoted to continuing education.

It is suggested that:

(a) **Post-secondary education at all levels be re-structured into 'continuous' form,**

(b) **Full flexibility be introduced into the system to permit a wide variety of rates of application and learning; a wide variety of part-time earning-learning arrangements, both on or off campus, all with recognition of the same form and value as may issue for full time attendance on campus.**

SELECTION PROCESSES

'Trial and error' continues to be the only process in use in the final determination of suitable graduates of engineering schools. The rates of attrition in all years of engineering exceed that in any other profession or course. There appears to be no initial screening or special test of any kind designed to determine either ultimate suitability or capability, as is the case in most other professional schools.

Universitites in Ontario generally admit any student to an engineering course who presents certain minimum academic qualifications in maths and sciences. Many a student enters engineering courses for negative rather than positive reasons; not because he has a clear image of the career he wants to follow; not because of demonstrated acknowledged aptitude, interest or background but rather because he believes he will not have to deal with people in an engineering career, because he did not do well in communications subjects or because he believes he may enjoy higher earnings. He comes because his father was an engineer; or to avoid taking up his father's business. Many choose engineering as they would a liberal arts course—it postpones selection of a final future career. An engineering graduate can still still become an accountant, lawyer, doctor, scientist, salesman or manager.

"This freedom of future choice", says Jay W. Forrester, "may seem a strength of engineering education, but it is difficult to focus on the definition and needs of a profession while helping lost boys search for their identity."

In any event, engineering course attrition rates are high, costs in terms of student frustrations and disappointments are high, costs in terms of facilities, operations and staff are

correspondingly high, with such substantial 'waste motion'.

It has been suggested that the output of an engineering course is far more sensitive to the input than to the curriculum. The Association is completely convinced that output quality or 'desired output characteristics' can be greatly improved, and the efficiency of the process raised substantially by the adoption of appropriate screening techniques. Many such techniques are already in use by other professional schools and might be reviewed seriously for adoption.

As noted above, the majority of persons entering engineering do so because they are of a personality type which seeks an important career dealing with 'things' and engineering appears to be one in which their chief associates will be a slide rule and a piece of hardware. To the consternation of these persons, they find that there is no way in which they can avoid frequent contact with all manner of people; far from being a rewarding experience to them it is one of great frustration, arising from their inability to communicate with, or work thru these people. This in turn has many consequences, not the least of which is chronic discontent and a strong tendency to collectivism. It is suggested that personality batteries are available now which could be used, not only to greatly improve efficiency but to change over a period of time the whole complextion of the profession.

There are even more important early aptitudes to be discovered, encouraged and nurtured. For instance, creative persons, innovators, now represent only a small portion of the total input in numbers but a major portion of output potential. Proper screening would suggest early identification of such possibilities, and channelling into environments particularly conducive to the development and strengthening of the basic ability. Similarly, those with entrepreneurial indications could be identified and 'cared for' especially throughout their term at the university.

From the standpoint of efficiency and effectiveness, it would appear quite possible to eliminate before entry a large proportion of those who will fail during undergraduate instruction, and some proportion, at least, of those who will fail later as practitioners. In any event it should be possible to direct the persons so eliminated from engineering course entry into some other training scheme, as for instance, the CAAT's, commensurate with their real interests and abilities.

It is suggested that:

(a) Major research programs be undertaken for the purpose of developing and implementing progressively, psychological and other testing procedures designed to identify the interests and the capabilities of all applicants for engineering courses; and

(b) Similar programs be developed, subsequently, for review of applicants for courses in engineering technology;

(c) Within practical limits, 'special treatment' be given to applicants with 'special potential'.

CAREER 'GUIDANCE'

If it is not the role of the universities to help 'lost boys', then the task must be undertaken in part, at least, by the secondary school. While it was noted earlier that special procedures were needed urgently to assist in the selection of 'appropriate' candidates for acceptance into engineering courses, and to reduce the exhorbitant attrition now resulting from the current 'cut and try' or 'hit and miss' system of selection, or more properly 'acceptance', it is suggested comment must also be made concurrently on the related process in secondary schools popularly termed 'career guidance'.

This process appears to be intended to be a combination of careers information service, course counselling, and crystal ball gazing. Its results relative to engineering appear to have been uniformally unsatisfactory both in Canada and in the United States, where both students and members of the profession have concluded frequently that career guidance programs had provided no discernible help or direction to students who ultimately found their way, via other motivations, into engineering courses; that the level of understanding of the profession, its duties, its responsiblities and its methods of practice was very low in guidance staff; and finally, that such staff needed substantially enlarged interest training, and reference facilities in order to do an acceptable job.

A recent meeting of the Ontario Interprofessional Liaison Committee, dealing with a recent guidance seminar, concluded almost precisely the same thing relative to a wide variety of professions. The experience of all those contributing to the discussion was unanimous–guidance teachers generally exhibited little or no natural or learned background or experience which was particularly pertinent to their positions, and further that the degree of interest in obtaining pertinent information on professions appeared to be almost non-existent. The Committee expressed its substantial concern with what it considered a most unsatisfactory system of selection and training of guidance staff, and its determination to bring the matter to the attention of the Minister of Education.

Improvements to secondary school guidance procedures will surely benefit selection procedures applied to any or all graduates.

Therefore, it is suggested that:

(a) The concept of continuous education be extended to 'pick-up' career interests in secondary school and to permit live involvement in some aspects of all careers at or before the 'point of decision' is reached

(b) The practising professional–and his professional organization–be 'employed', or 'utilized' by secondary school administrators or 'guidance' teachers in a for-

mal and a planned manner, rather than informally as now applies. The knowledge is there in the practising professional—or for that matter, in individuals engaged in any trades or vocations—and could be brought out with a satisfactory aid system.

(c) Centralized computer information services relating to all careers be established and made available to all secondary school systems—utilizing, perhaps, the same facilities suggested later for post-secondary educational institutions.

ENGINEERING TECHNICIANS AND TECHNOLOGISTS

No remarks about the future of the engineering profession can be considered useful without proper reference to one of the members of the technological community—the engineering technician or technologist. Currently considered to be the answer to many of the special needs of industry, engineering technicians and technologists are now graduating in major numbers from CAATS and Ryerson and from other similar institutions. The engineering technologist has developed the capability of supplying the practical, technical knowledge needed by industry and no longer available from the 'current' engineering graduate who has theoretical, and scientific orientation, and essentially no practical experience. Such persons are considered 'over-trained' for many industrial occupations, where the technologist is able to form a natural bridge between the theoretician (engineer) in support of whom he usually works, and the trades person who translates the technical data into hardware or software as the case may be. There seems no doubt that overall technical accomplishment in the future will be the result (increasingly) of 'team' effort, with the specialist engineer, the generalist engineer, and the engineering technologist combining their particular talents to produce the appropriate theory, to apply the judgement of experience, and to connect the project with the practical translation processes, respectively.

Education and training procedures—with a practical rather than theoretical 'flavour'—of the current engineering technologist are considered by some to provide a technical capability equivalent or, indeed, superior to that of engineering graduates of the 1950's. Be that as it may, there is no doubt that the technologist has been well accepted in industry, and has been performing well. There is no doubt that he is better suited for certain industrial employment than is the more theoretical graduate of a university engineering course. This 'success', however, will be followed by increasing demands from the technologist himself for means to enlarge his career interests, capabilities and opportunities. Such opportunities can be expected to include: continuing education courses, advanced courses—probably leading to a Bachelor of Technology degree—and finally, the ability to move much more freely into professional courses at university level.

It is suggested that five possibilities are worthy of consideration in respect of the foregoing:

(a) The designation of one of the present institutions to be the centre of advanced education for the technologist —and the one such institution to grant suitable degrees in recognition of accomplishment.

(b) The designation of one or more of the present institutions to be the centre for continuing education activities for all technicians and technologists.

(c) Engineering Technologists—and technologists related to other professions—be given equitable opportunity to enter university professional courses at earned (rather than present arbitrary) level.

(d) Suitable 'transition courses' be made available to technologists by universities with the object of preparing the technologist to enter the desired degree course at the highest possible level, and to complete the university requirement in the minimum possible time.

(e) Effective integration of programs given at university and college level be arranged to eliminate duplication of many courses now given at both institutions in the same general geographical area; and that Colleges of Applied Arts and Technology become 'feeders' to engineering courses, which ultimately could be shortened significantly to become 'post diploma' courses involving perhaps two years of attendance at the university.

PROFESSIONALISM IN THE UNIVERSITY

"If engineering is to be a profession, the engineer should operate at a level of integrity well above that expected in the public domain—yet the educational system places little emphasis on integrity, seldom examines the meaning of integrity in engineering practice, and conducts its own processes at an integrity level little higher than that of the outside Society."

This is how Dr. J.W. Forrester, Professor of Management at MIT sees the current attitudes of the engineering education system in the USA. While parallels are not exact in Canada, nevertheless the professional associations in the provinces have on many occasions expressed great concern that such 'professional' matters as legislation, organization of the profession, code of ethics, rules of practice, economics, employment practices, responsiblities and obligations, and independent practice have not been considered worthy of inclusion in the system or the curriculum.

Engineering faculty members often gain their academic qualification thru reasearch, and much too infrequently thru professional practice. Opportunities for consulting—participating in small degree in the real world of professional practice—are often closely controlled by universities, and usually regarded as 'unfair competition', by practising engineers in independent practice.

This attitude or practice is in marked contrast to that found in other professional schools where faculty members are not only expected to have extensive relevant professional experience, but to maintain professional competence as a

duty, not a privilege. Provision is made for some measure of continuing professional practice.

Concern is expressed at the apparent rejection of professional registration by university staff teaching engineering subjects to engineers. It is understood that proportions of staff who are registered runs from 20% to 50%—and in many instances this has been undertaken to permit part-time consulting practice to be carried on—but rarely as an 'example' to the student engineer. Similar concerns exist over the apparent insulation of the student from the realities of professional practice or the neglect of means of helping the student, early in and throughout his university career, relate to the realities of professional practice.

This concern has been expressed by many, including Jencks and Riesman in 'The Academic Revolution' (1968). They say:

"Engineering professors, for example, are usually interested in turning out men with skills, appropriate for teachers of engineering. They simply take it for granted that these skills will also be appropriate to the practice of engineering. In many cases, of course, they are right but in many cases they are probably wrong."

It is therefore suggested that:

(a) Professional experience be regarded as being at least equivalent to research as a qualification for engineering teaching;

(b) Professional registration be a requirement for teaching of engineering subjects;

(c) Professional practice for the engineering teacher be required and be obtained or encouraged by industrial or consulting sabbaticals, and by substantially increased opportunities for periodic professional practice during teaching appointments.

THE DEGREE FETISH

Many people are critical of the current reliance of certain elements of society on the degree as a measure of the worth of an individual to society as a whole, or as a criterion of suitability or capability for a particular position. Such a feeling is surely a hang-over from a previous generation when the holding of a degree was a personal and unique accomplishment which indicated:

- a measure of personal determination and ambition
- a measure of perseverance, dedication and endurance
- a minimum native intelligence level
- a potential for growth and development

'Familiarity breeds contempt'—and a vastly increased number and proportion of degree holders, many of whom entered an almost fully subsidized system without real desire, dedication or career motivation, can surely do nothing but dramatically dilute the 'degree' as a measure of uniqueness in either training or personal qualities.

Many cost-benefit studies have shown, too, that 'degrees' —and particularly advanced 'degrees'—do not suggest that a significant lifetime *economic* benefit will accrue to either the individual or to society. It can be readily deduced then, that society is providing for the personal career satisfactions of a goodly portion of those indulging in the relatively free 'degree' stream. Such an observation can lead to only one conclusion—those who seek these personal satisfactions should pay for them—in much greater proportion than is current, with, of course, appropriate means of assisting the 'selected' student of high potential, (see 'Selection Processes' above).

The tendency today appears to be leading to universal free post-secondary education. Some persons even consider that there should be some amount of compulsion, as there is in universal secondary school education. This drive appears to arise from American experience which attributes 20% of its economic growth to rising levels of education, and as much as 40% of increases in per capita income to the same source. However, there are surely signs on the horizon that economic growth at current rates may no longer be either an acceptable objective, or even a possibility as far as accomplishment goes; 'saturation', due to many influences and circumstances, now appears likely.

Many decry the 'discrimination' which they believe attaches to an employer's use of the degree as a determinant in hiring, saying that ability and not an educational fetish should govern. However, as yet no practical alternative has been proposed for the employer, who would then surely have to make his decision on a proven record of performance in a particular field, or on the applicant's own assessment of his inherent abilities. Be that as it may, elimination of the degree (diploma, certificate) would remove the only more or less objective assessment of the individual available, at least in the early years of employment.

If one acknowledges that the degree is an outmoded fetish some substitute 'proof of mastery' must be devised. One of the most likely instruments of course, is the letter of recommendation from the previous employer—subjective as it very likely will be. Failing this, one is led back to the educational institution which (presumably) would attest to attendance and general area of study of any student. Thus, the student would have to remain 'anchored' to the educational system until he had established suitable 'proof of mastery' by successful employment. This situation suggests that the educational process should then be changed from a segmented, or periodic mode, to a continuous mode, as already suggested elsewhere.

In technical educational systems where the non-degree person has predominated, as in the U.K. for instance, technical bodies have become 'qualifying' bodies, and membership has become 'proof of mastery'. Professional 'mastery' could similarly be attested to by self-regulating professional bodies through an examination system, and the certification of membership in varying 'degrees'. Such an arrangement, of course, provides no solution in itself for the major-

ity of persons who are not interested in a licensed profession. It does suggest that voluntary technical scientific or liberal societies help to 'bridge the gap' between education and meaningful experience.

It is suggested that:

(a) An investigation be undertaken jointly by university and professional–technical organizations with the object of developing a 'proof of mastery' system which will better describe both the accomplishments and the potential of an individual than does the current 'degree' or 'diploma' system.
(b) A similar investigation be undertaken by Colleges of Applied Arts and Technology jointly with suitable existing voluntary occupational groups or societies.

INSTITUTIONS

Future consideration of institutions giving post-secondary instruction cannot neglect the classic "6/10 power law"–which basically emphasizes the economies of scale in plant, facility, or organization. While no estimate of the correct value of the exponent n in the equation cost = k^n (capacity), relative to education is recorded, nevertheless all indications are that it is less than 1. It is suggested that educators or administrators could even now bring to bear sufficient cost data to establish, for Ontario, the minimum size of engineering faculties (or of complete universities) for viability, and equally the maximum practical size which will avoid saturation effects.

Regardless of the foregoing, sufficient flexibility must remain in the approach to permit experimentation and development. For instance, the anticipated re-shaping of engineering curricula progressively toward environmental and societal emphases could (and should) begin *now* in one or two existing institutions, which would be designated 'experimental'. Coincidentally, initial environmental courses, should be introduced into all existing engineering curricula.

Opportunity should similarly be made for an immediate study of the desirability and practicability of the early creation of one or two 'centres of excellence'–particularly in respect of postgraduate study. A review and coordination of courses given at existing institutions should be made for the purpose of 'eliminating, transferring or combining' such courses to avoid needless duplication of facilities and staff, and to aid overall viability.

Utilization of existing plant should be reviewed with the object of greatly increasing the annual load factor. The sky-rocketing cost of capital construction, operation and maintenance, drives economy-conscious enterprises to minimize the element of committed cost in the unit output cost by continuously increasing utilization of fixed facilities. Two-shift 240 day per year operation would in many instances be considered minimal. Universities must begin thinking about dropping the traditional 7-months per year degree courses and providing by better utilization of fixed facilities substantial immediate capacity increases, and significant deferments of capital requirements for growth or expansion.

It is therefore suggested that:

(a) Criteria for both viability and saturation be established, both for particular faculties, and for entire institutions and that these criteria be applied both to new and existing institutions;
(b) One or more existing institutions be designated as 'experimental', and used for the early development of new courses, processes or methods;
(c) Serious and immediate consideration be given to increasing university, college, or other post-secondary or educational facility usage from 'periodic' to continuous.

REASEARCH FOR INCREASED PRODUCTIVITY

'Mission-oriented research' is a current catch phrase being used in the context of improving the relevance and the effectiveness of research programs undertaken in and by universities. With a significant proportion of all research being undertaken by or thru universities, a move to make this research more applicable to society and all of its problems is to be commended.

However, there appears to be a serious deficiency yet remaining in the educational system–the biggest 'business' of them all, with budgets running into billions of dollars. A remarkably small portion of that income much less than 1%, is earmarked for research and development programs to improve productivity in this educational 'business'.

No business charged with being profitable in a competitive environment would consider that it could maintain a suitable progressive position on such a small assignment of resources to 'improvement'. In the face of mounting costs of all kinds, straining every source of income, in the face of rising 'demands' for service and resulting increases in cost per unit output, surely all educational institutions should maintain an R & D program devoted to self-examination and improvement. Starting from a base of minor activity only in this respect, the pay-off of initial organized effort should be startling–and should be sought immediately.

While formal 'product improvement' programs, in addition to or in substitution for certain mission-oriented research and development programs, are greatly to be desired, a further source of man-hours to apply so these problems currently remains untapped–the postgraduate student. With the almost universal emphasis today on research as the only route to a post graduate degree, thousands and thousands of student man-hours are being channelled into often non-relevant research topics or projects, directed by instructors or individuals, as 'academic' projects having as their end objective and result the postgraduate degree. These students can be utilized with double-barrelled benefits–they can become involved in relevant social, professional and education-

al problems to their own immediate benefit, and to the ultimately probable benefit of the educational system, the profession and indeed society as a whole.

It is therefore suggested that:

(a) Major programs of research and development be established at all post-secondary institutional and administrative levels, directed towards improvement in effectiveness and in 'cost-benefit' ratios of educational methods, curricula, facilities and staff.

(b) Postgraduate research programs be slanted wherever possible to these same objectives

(c) Postgraduate research programs being supported by public financing be restricted to currently significant or pressing social problems.

PERFORMANCE CONTRACTING

Education has been largely a matter of public concern, financing and control, and over the period of many years has seen private educational ventures largely submerged, or at least subservient to governmental control in many areas. The fact of this submergence has minimized the application of methods or techniques found to be successful in commercial, industrial or business activities, in educational processes.

A recent 'opening of the door' has occurred in USA through a major experimental project launched by the US Office of Economic Opportunity. The basis of the program is 'performance contracting', whereby private educational organizations bid on and guarantee results, on a pupil/grade basis for individual or groups of subjects. 170 'contracts' have been let, and on the basis of this limited experience in public school experiments have indicated that rates of student progression 1½ times the current norm have been attained, 3 times in the case of retarded students--a significant 'break-thru' in a limited segment of the educational spectrum but one which should have equal applicability in other segments.

It is suggested that:

(a) Commercial or contracted teaching, guaranteed as to progression results be instituted in specifically selected institutions and fields of learning, in all post-secondary types or levels of education from trades training to doctorate, on an 'experimental' basis.

CENTRALIZED FACILITIES

Instructional Television (ITV) Closed circuit television teaching systems and courses have been employed for some time at all levels of education to assist conventional teaching, with varying degrees of success. In University instruction in the USA, for instance, terms such as ITV, 'teleclass' and 'telecourse' are becoming commonplace. Such descriptive designations (acronyms) as 'GENESYS', 'TAGER', 'ACE', 'SURGE' illustrate the varying uses to which this important tool is being put in some twenty engineering schools in USA. However, as far as is known, no such systems have been employed in Canadian engineering schools.

ITV is one of the principal examples of a centralized facility which contributes to attainment of the triple goals of improved quality of instruction, reduced cost of instruction, and increased coverage or availability of instruction. Successes in US schools cover regular classroom, satellite classroom, remote campus, and off-campus instruction, both in regular and continuing education fields.

There seems no question but that centralized instruction programs represent one of more exciting coming teaching methods which will make it possible to provide the 'best' instruction, both on an individual or panel basis, to a much larger group than otherwise possible, to provide it with a degree of uniformity, and at an appropriate level, with student participation or 'talk-back'. It seems reasonable that no future consideration of facilities or processes related to post-secondary education can be undertaken reasonably without the incorporation of centralized TV instructional facilities.

Information Storage and Retrieval With the 'explosion' of scientific and technical information, conventional library storage, retrieval, reproduction and summarizing are becoming too unwieldy and time consuming in educational as well as business and industrial spheres, where centralized computer information storage and retrieval systems have become a necessity. Central computer facilities are capable of providing full service to some if not all engineering schools in the province, for instance. Such a system would provide to every school, no matter how small or impoverished, the quality and extent of information available to the largest and best supported.

Central Processing Unit (CPU) Centralized computer facilities are capable of providing to individual institutions, or to groups of institutions, full scientific and business services--and, of course, specialized instructional services, as noted below.

Computer Assisted Instruction (CAI) As of the beginning of 1970, it is understood that 910 CAI programs are currently being carried on in 85 educational institutions in USA, with initial favourable indications. While the problems and the promises of the use of computers in education are still being studied intensely, the fact that no fewer than eight major studies--launched both by private and government agencies--are now nearing completion, that 50 US journals are devoted largely to this and to related subjects, would indicate that most serious consideration should be accorded the subject in any overview of post-secondary educational facilities in Ontario.

Closely related and not to be omitted in any consideration of instructional techniques are computer managed instruction (CMI) and a host of techniques between these two, all based on the use of central processing units (CPU).

It is suggested that:

(a) **Current individual, departmental or institutional projects or studies relating to ITV, CPU, CAI, CMI, or CIRS, be coordinated and consolidated at provincial level for the purpose of applying the broadest perspective to the ultimate installation and most effective use of centralized facilities.**

GENERAL

Specific comment on the suitability of present engineering curricula, on the 'needs' of industry employers, on the 'market' for postgraduate degrees, or indeed on the specific requirements of the Canadian economy–now and in the future–has been avoided, as trespassing particularly on the territory of the Study on Engineering Education in Ontario, commissioned by the Committee of Presidents of Universities of Ontario, and now about to issue.

It is further appreciated that the comments given above are, to an appreciable extent, tangential to the specific terms of reference of the Commission. However, they do represent the 'areas' of concern which have been identified by members of the engineering profession, and it is the hope of this Association that the Commission will find them useful in its overall deliberations.

Association of Professional Engineers
of the Province of Ontario

L.S. Lauchland, P.Eng., President

11/70 CG

NOTICE

EXAMINATIONS FOR ADMISSION TO THE PRACTICE OF PROFESSIONAL ENGINEERING

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF ONTARIO

Background:

The Association of Professional Engineers of the Province of Ontario conducts an examination program, to enable those whose academic qualifications fall short of the requirements for registration, to meet these requirements through passing examinations set annually by the Association. Admission to the examination program has, in the past, been granted to persons possessing qualifications which at least would admit them into the first year of a four-year engineering course at an Ontario university i.e. Senior matriculation or its academic equivalent.

The Council of the Association has now taken the decision that an engineering degree shall be adopted as an essential requirement for admission to the pre-registration examination program, with the understanding that confirmatory examinations will be required of all applicants presenting degrees from courses not recognized for complete exemption. The foregoing is considered to be the final objective of an orderly and planned program of evolution of seven years duration, to enable those persons who plan eventually to attempt to enter the engineering profession in Ontario to plan their future educational endeavours accordingly.

Copies of the plan for phasing-in the new admission requirements will be available from the Association of Professional Engineers of the Province of Ontario, 236 Avenue Road, Toronto 5.

SEVEN-YEAR PLAN FOR ADOPTION OF AN ENGINEERING DEGREE AS THE REQUIREMENT FOR ADMISSION TO THE PRE-REGISTRATION EXAMINATIONS

1. **First Year of the Plan,** January 1st, 1971 until December 31st, 1971. During this year, applicants will continue to be accepted into the examination system on the same basis as in the past, i.e. senior matriculation or its academic equivalent. Such persons can expect to be required to pass all of the examinations in the syllabus pertaining to their chosen branch of engineering, and are given seven years in which to do so, provided that a satisfactory level of performance in the examinations is maintained. All persons who are currently in the examination system will be unaffected by this new policy. The conditions as to time limitations, performance in the examinations etc., of which they were notified upon admission to the examination program, remain in effect.

2. **Second Year of the Plan,** January 1st, 1972 to December 31st, 1972. During this year, applicants will continue to be accepted into the examination system with the same academic qualifications as before, but the maximum time they will be permitted to complete the examinations will be *six* years.

3. **Third Year of the Plan,** January 1st, 1973 to December 31st, 1973. During this year, applicants will be accepted into the examination system only if they possess the qualifications of an Engineering Technologist (either through having graduated from a three-year engineering technology program following Ontario Grade 12, or through having become certified as Engineering Technologists by the Ontario Association of Certified Engineering Technicians and Technologists) or higher.

   The maximum time they will be permitted to complete the examinations will be *five* years.

4. **Fourth Year of the Plan,** January 1st, 1974 to December 31st, 1974. During this year, applicants will be accepted into the examination system if they possess the same qualifications as under 3 above, the maximum time allowed for the completion of the examinations being *four* years. Such candidates should be aware that they will probably have to pass at least two and more likely three papers a year, in order to complete their examinations within the allotted time.

5. **Fifth Year of the Plan,** January 1st, 1975 to December 31st, 1975. During this year, applicants will be accepted into the examination system only if they possess qualifications which would have admitted them into the third or fourth year of a recognized 4-year engineering course at an Ontario university. The maximum time they will be permitted to complete the program will be *three* years. Such candidates should be aware, as in 4 above, of the necessity of passing two or three papers a year in order to complete their examinations within the allotted time.

6. **Sixth Year of the Plan,** January 1st, 1976 to December 31st, 1976. During this year, applicants will be accepted into the examination system only if they possess qualifications which would have admitted them into the fourth year of a recognized four-year engineering course at an Ontario university. The maximum time they will be permitted to complete the examinations will be *two* years.

7. **Seventh Year of the Plan,** January 1st, 1977 to December 31st, 1977 and henceforth. Only those applicants who possess an engineering degree, granted by a university which is not specifically recognized by the Association for

complete exemption from the examinations, will be admitted into the examination system. Such candidates will be required to pass the "confirmatory examinations" within *two* successive examination sessions, in accordance with present regulations pertaining to such examinations.

Note:

1. It has been the practice, in the case of candidates admitted into the examination system after September 1st of any year, to allow them one extra examination session beyond the nominal time limitations, in order that they may adequately prepare themselves for the examinations. This principle will continue to be applied in the foregoing plan.
2. Applicants possessing engineering degrees from universities recognized by the Council of the Association, are and will continue to be admitted to membership in the Association without written examinations.